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Photomacrography of Insects*

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INSECT photography has not only the value of its own right but also offers the reward of training the photographer in photomacrography. For in addition to the ordinary photographic problems of controlling subjects that walk, run, hop, fly, squirm, or swim out of the picture, the photomacrographer has the special concern of making a compromise between depth of field and resolution. And the later is one of the major technical considerations of photomacrography.

Handling Subjects

The cardinal principle when dealing with live subjects is: bring the specimen to the camera, not the camera to the specimen. This is not as obvious as it seems.

The camera should be ready for the exposure before the insects are introduced. It should be focused on a dead specimen of the same or similar species; or on some object of comparable size. The flash or electronic-flash lighting units (which are the most practical for indoor and much outdoor work) should be arranged to suit the subject. The exposure (see Table I) should be calculated from previous data or meter readings off the hand or grey card and the shutter cocked.

Then the live subject can be dumped, chased or coaxed into the field. For example, a caterpillar can be urged up a twig with a camel's hair brush; two pieces of tape mark the limits of the field on the stick. A frame, such as a small picture-frame, or the edges of a hole cut in a cardboard carton serves to mark the field for lively moths, beetles, and the large "flies". These specimens should be chilled for about an hour (or more) in the food section of a refrigerator. They are then permitted to cling to a stick and quickly placed in position over the frame at a predetermined clearance for focus.

Subjects like ground spiders or scorpions (if I may take liberties with the title of this paper) can be chased into a small "landscape". Certain landmarks, like sticks or pebbles in the corners will indicate the field. Four pennies, just outside, are often helpful too. Aquatic nymphs can be positioned close to the front glass of a small tank by means of another sheet of glass. Water-surface striders can be confined to a photographic tray with four panes of glass arranged like a fence. The "bottom" can be built up like the "landscapes" mentioned before. Some insects, like mantes, can be coaxed with a meal into the right position and then remain there contentedly munching.

Many of the above expedients can be used indoors or outdoors. In addition, a flower outdoors is often an attractive

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lure for a subject, provided the photographer studies what is visiting what and then waits-out the action. Grass stems treaded through the plant growth can serve as a frame to indicate field and focus for some subjects. Of course, focal frames are useful, especially if the principle offered is to be departed from — you *can* chase some subjects with a focal frame. Yet even here, the best records often result from getting the subject to go into the frame, with the frame and camera on a tripod.

There are methods of anesthesizing insects with ether, alcohol, crystalline urethane, or with injections of cocaine. However, unless exacting dosage requirements are met the subjects contort to horribly unnatural attitudes under the influence of such drugs. Some of them "come out of it" easily and can be photographed in the process. However, most insects undergo violent convulsions during the coming-out period and these make photography impossible. The author prefers the chilling method — after all, it is a natural process, and a reasonably natural emergence is the rule. This recovery from enforced hibernation is sometimes rapid though; so the photographer has to be ready for the desired pose. A normal attitude should be readily forthcoming. There may be a puzzled expression on the subject's face from the rapid seasonal changes; but we are after a figure study, not a portrait.

There are two ways of arranging a dead insect. First there is the entomological style, in which the specimen is pinned or else positioned to reveal some key to its identity. An experienced entomologist can best arrange such a specimen. The second method is to pose the subject so as to stimulate life. This is tricky and requires careful study of a lifelike attitude. The antennae, in particular, are difficult to set in a convincing alignment. Both methods (but imperatively the latter) call for freshly killed specimens for best results.

TABLE I
Photoflash Lamp Guide Exposure Numbers for Close-Up Photography
(For bare lamps, no reflector, and distances in inches)

Exposure Index of Film	Shutter Speed	Guide Numbers* for Lamps Shown	
		No. 5	No. 22
10	1/25†	264	384
	1/100	216	324
	1/200	192	264
	1/400	132	192
40	1/25†	544	746
	1/100	456	628
	1/200	374	544
	1/400	272	374

*To calculate the effective *f*/number divide guide number by distance *in inches* between lamp and subject. If the effective aperture *has* to be a given value, the distance in inches can be found by dividing the effective *f*/number into guide number. Electronic-flash units with same guide numbers (in feet) as the lamps given here, call for the same close-up guide numbers.

†Same guide number holds for open flash technic.

In preparing a text book illustration, the artist will *draw* a perfect specimen, so why should not the photograper *photograph* an undamaged specimen for the first purpose? Obviously, a "cripple" is not good for the second. In many instances the only way to procure a good subject is to raise it. This is especially true of butterflies and moths.

Optical Considerations

There are a few simple formulas that the photomacrographer needs. The first deals with magnification — data that must be noted carefully for each record. In handling the camera, the bellows draw must be set for the desired scale and focusing done by moving the entire camera or the specimen support. In this way, the lens does not shift and change the image size. The desired lens-film

distance "v", for a given magnification "m", is:

$$v=(m+1)F$$

where "F" is the focal length of the lens. This indicates the bellows-length requirements for any magnification. Notice that as "F" is decreased, "v" decreases. Therefore, a lens of short focal length is often an asset when the camera has a short bellows.

It may be required to find the magnification obtainable with a given setup. Then we have:

$$m=(v/F)-1$$

When the bellows draw and the magnification are known, a lens of the needed focal length can be selected from the following:

$$F=(v/m)+1$$

For exposure, resolution, and depth-of-field considerations the concept of the effective lens aperture must be employed. The *effective aperture* is: the *relative aperture* (the one marked on the lens, which is accurate at infinity and acceptable at ordinary distances) multiplied by (m+1).

The question often arises regarding the comparable merits of lenses with long and short focal lengths. Apart from the dimensional aspects of the camera, discussed above, there are only two considerations. First, the lens of longer focal length is used farther away from the subject. This gives more working space between specimen and lens and this sometimes lends better perspective. With regards to depth of field it should be noted that optically the amount depends upon magnification and effective aperture, not upon focal length[1].

The second factor is covering power. In photomacrography the size of the camera or film is immaterial. The important detail is the size of the specimen. It should not be longer than the focal length of the lens, when ordinary camera lenses are used. For working with cine lenses, used on still cameras for relatively high magnification, the specimen should not be longer than half the focal length.

Resolution and Depth of Field

With whole insects smaller than bees, the eye facets can and should be resolved. With larger ones, the segmental joints in the antennae, or fine pores or hairs on the body should be reasonably sharp. When extreme close-ups of parts of the specimens are photographed, the critical details will depend on the subject.

The resolution of an individaul lens needed to accomplish these ends will depend on its quality. Therefore, first-class camera or enlarging anastigmats are imperative. Sometimes a lens will work better if placed on the camera backwards. This can be determined by photographic tests.

Besides the quality factor, however, there are certain basic optical effects that occur with all lenses. The resolution decreases as the effective aperture is increased (numerically, or decreased in size), because of diffraction phenomena. Hence the blissful stopping down that is done to increase the depth of field often decreases it and reduces the ability of the lens to resolve the desired order of detail.

As a result of this, one of the major tasks of photomacrography is balancing resolution and depth. This can only be done from experience and a guide can only be indicated in a general manner. The problem is further complicated by the fact that depth of field decreases with magnification. Therefore, there is a limit to which a subject of given form and size can be magnified and still record satisfactorily. For example, it is optically

impossible, even with a "perfect" lens, to make a 14-in. x 17-in. print of a house-fly and have every detail over all the specimen correspondingly as sharp as it would be in a gargantuan fly. And if the sharpness is equalized throughout the image by extreme stopping down, then the print is unsatisfactory in resolution all over — unless it is viewed from the opposite end of a long hall, which would defeat the purpose of magnification. There is a need to keep "empty magnification" in mind for photomacrography just as is the case in photomicrography.

The author adopts the following criteria in reasonably critical work to avoid the effects of diffraction:

Aperture for maximum practical resolution — Monochrome: f/16; Color: f/22

Aperture for good compromise—Monochrome or Color: f/32

Aperture for maximum practical depth — Monochrome or Color: f/45

Commonly employed fine-grain films have an inherent resolution greater than color films, and therefore two values have been given in the first class above. The size of the camera need not be considered here, for it is the magnification of the image that is the ruling consideration in photomacrography.

Then, to juggle the factors of reasonable resolution and depth of field for practical magnifications, the following tabulation shows how large it is feasible to record insects of various sizes on Kodachrome Film.

Head of fruit fly	X15
Dorsal view of fruit fly	X7
Ladybird (small, dorsal)	X3
Wasp (dorsal)	X1½
Stag bettle	X1
Goliath beetle	X½

Considerations for Critical Work

In obtaining the optimum balance between resolution and depth of field, the following principles should be kept in mind. The order of detail — eye facets, antennae, pores, legs, etc. — to be recorded in the insect should be decided (Figure A)*. A degree of resolution should then be planned that is no greater than that required to resolve such detail. This will relieve the depth-of-field paucity by permitting the maximum effective aperture to be utilized. Here caution should be employed and test exposures made because the increased diffraction from stopping down reduces the overall resolution. Yet it only increases depth of field up to a certain point, after which depth falls off and finally the over all resolution becomes too poor to accept (Figure B).

Another way to gain depth is to select the lowest feasible magnification (Figure C). However, reducing the scale in this way must not be carried to the point where the graininess of the film becomes a detracting factor. Not only is the intrinsic optical resolution made unattainable by graininess, but the depth of field is reduced also (Figure D). In other words, the practical overall sharpness of a depth in a print seems to be acceptable so long as the visualization of the order of detail in which we are interested has not been seriously impaired by factors like graininess. It is true that a photographer can make comparisons and note that actual sharpness may be impaired before the desired detail becomes too fuzzy. However, the viewer is not so prone to make such comparisons because the photographer gives him only one print and because he is mainly interested in the pertinent detail. And at the other extreme of reso-

*Only Figures A, B, C, and D are referred to in text.

lution, he is not concerned with metallographic details of these file teeth even if they could be picked up with a magnifier on the gross print. Obviously, a film of low graininess should be utilized to minimize the effects of this factor. Photographic tests at varying magnifications may be needed for critical work.

Besides these optical adjustments the photomacrographer can also help himself by careful arrangement of the subject. For example, a cross-light on the critical areas will increase the contrast of their details and provide a subject that will record sharper. Then, the critical areas should be located as close to one plane as possible. Non-critical areas somewhat beyond the depth of field will not be distrubing if located near the margins of the print or in the "shade". The use of electronic-flash lighting helps to maintain the maximum sharpness by virtue of minimizing subject motion — even still or dead specimens are likely to vibrate (or the camera may do so). However, with still set-ups *only one* flash should be given, otherwise you may double-expose two or more different phases of vibration and reduce sharpness. In a field where so many factors are stacked against the photomacrographer, these precautions and the obvious one of providing a steady support for specimen and camera lead to satisfactory results.

Acknowledgment

Several of the illustrations in this paper originally appeared in *Medical and Biological Illustration*, reference below. I wish to thank the editors for permission to reuse those illustrations here.

REFERENCE

1. Gibson, H. Lou, Technical Considerations in Photomacrography, Medical and Biological Illustration, II, No. 4, 247, (1952).

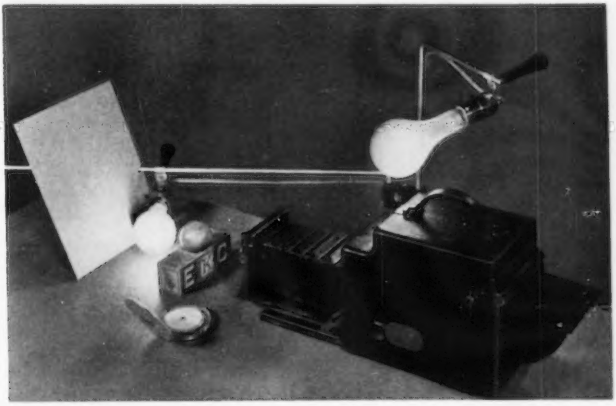


Figure 1. The basic lighting set up for insect photography. The main lamp provides a natural single light source; mirror fills in shadows. Direction of main light should be such that desired details are modeled, usually toward head of insect, slightly above lens axis. Sometimes a background light is useful. Here, card is illuminated to simulate sky tone; tilting it provides gradation. Background light should not shine into lens, but a little spill-over on subject can offer backlighting. Bare lamps constitute relatively small light sources, yielding crisp definition.

Figure 2. This shows the head of a wasp emerging from the pupal cell and what the lighting illustrated in Figure 1 can produce.

Figure 3 (a). The entomological style of record is shown in Figures 3 (a and b). Here are fireflies *(photinus marginellus)* arranged to show keys to their identity. For lighting this type of subject, a "copying setup" is generally suitable. However, the lights should be in a plane about 1 foot ahead of the insect. This will give a little of the effect of a "top light" resulting in more natural-looking photograph.

Figure 3 (b). This is a harlequin beetle *(Acrocinus longimanus)* pinned and photographed from a close range to show detail in the elytra. The forelegs of this insect are much longer than its body and another shot would be required to show this feature.

Figure 4 (a). This polyphemus caterpillar was chased up the stick, previously positioned for focus and marked for field.

Figure 5. Certain short-lived insects can be found in a moribund state and are then quite tractible. Such was the case with this mosquito (*Mansonia perturbans*, Walker). Since it "could scarcely stand up" it was easy to overcome depth-of-field problems by spread-eagling the specimen. This is not a natural pose but it shows all details.

Figure 4 (b). The polyphemus moth (left) is just coming out of enforced hibernation in an ice box. While fluttering on the stick it was brought to a cardboard frame in front of a background. The frame indicated focus and field. Thus, *living* insects show better the attitudes of specimens.

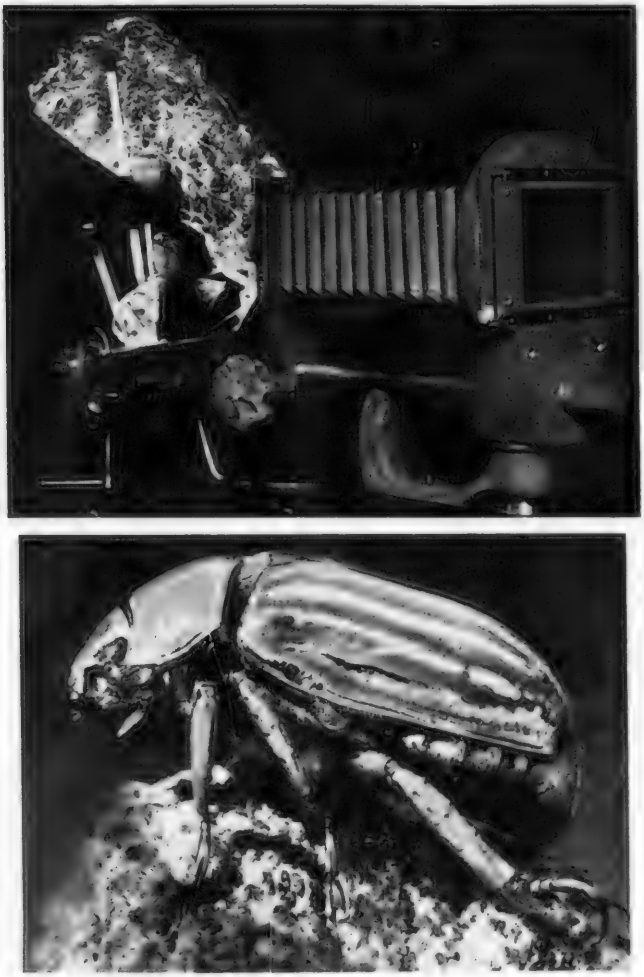
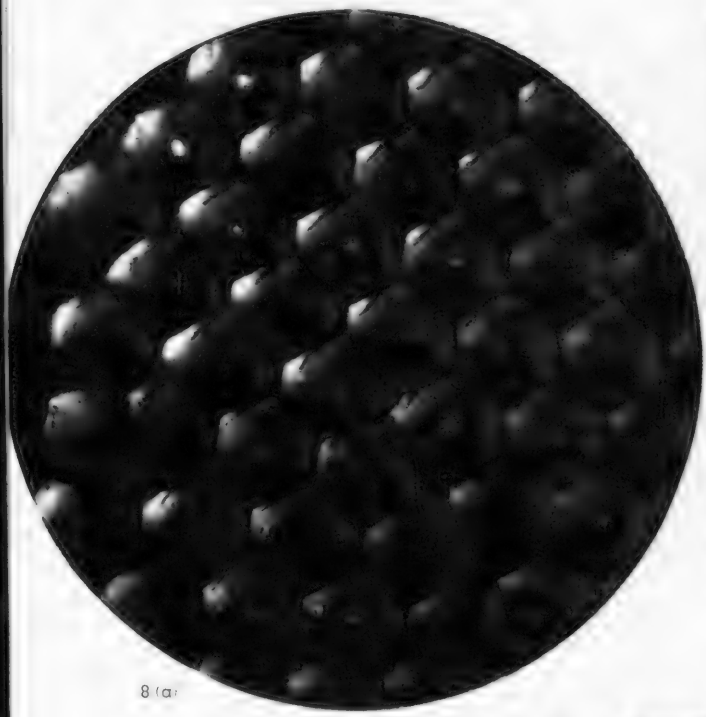


Figure 6 (a and b). Modelling clay used to support the "scenery", as well as sticks to cast judicious shadows, Scotch tape to soften highlights, foil (or a mirror) to provide fill-in illumination all shown in (a) often overshadow the poor little insect. Yet they are all important because the miniature set has to be treated like a large set for a commercial illustration. Relatively speaking, light-source sizes can be made comparable by using bare lamps for photomacrography, (sometimes clear to take advantage of the small filaments). And another point important in color photography is to avoid a "green studio", i.e., do not have an excess of green leaves all around the specimen because they will produce a bad color cast over the specimen. In (b) is shown the resulting simulated sunlight effect appropriate to this scarab (*Plusiotis gloriosa)* from Arizona. Here, crumpled lead foil provided "silver walls" to enhance the rare silver coloration in this insect.



8 (a)

Figure 7. Electronic flash was used here to stop motion of energetic, acrobatic spider *(Aranea sericata)* on its line.

Figure 8 (a, b, c and d). The negative magnification selected will depend on the detail or part to be recorded. The image size on the enlargement will be governed by the intended viewing distance. These woodboring beetle records serve to demonstrate the point: (a) 110X, to record the structure of the individual eye components (done with a microscope); (b) 3X, to reveal the arrangement of facets on the eye; (c), next page, $1\frac{1}{2}$X, to show details of the head; and (d), next page, 1X, for the entire insect. Specimen reproduced here at 2X scale.

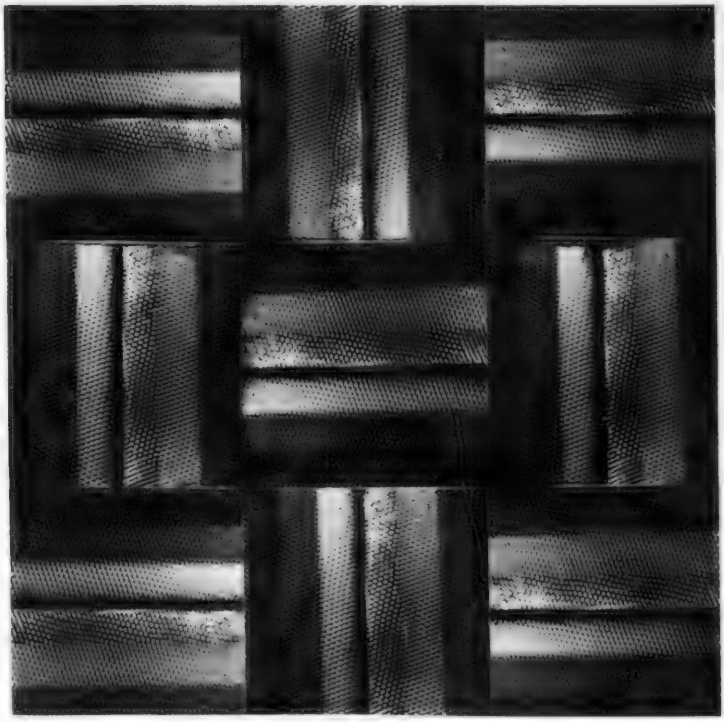
8 (b)

8 (c)

8 (d)

Figures (A to D). The "artificial butterfly" made up of iron files was photographed with a Kodak 200-millimeter f/7.7 Ektar lens. The camera set up was mounted on antivibration mountings and exposures were made by turning on and off a distant switch. A specially constructed film-holder maintained an accurate lens-film distance once the bellows draw had been set for a series of exposures. All enlargements were made with Kodak Projection Ektar lenses at f 5.6. The pertinent scales are indicated by "m" which is the magnification at the negative, and by "M", which is the total magnification. Other explanatory notes are given for each illustration group.

Figure A
(a)



Magnification at negative (m) was 0.333. Total magnification (M) as reproduced here, 1.2. For strip (M) equals 14.

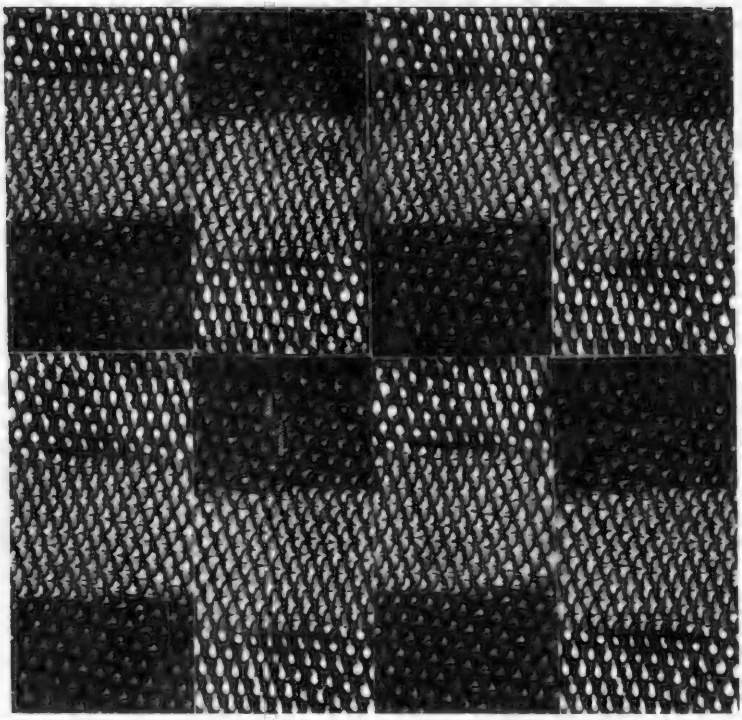


Figure A
(b)

Magnification at negative (m) was 1.0. Total magnification here (M) is 4. For strip (M) is 14.

An "artificial butterfly" was used as a test object to find practical depth-of-field data. The metal files are joined to a wooden block and the teeth provide "wing scales". Bands of gray color sprayed on the files permit investigating the effects of subject-tone. The paper gray scale (with corresponding grays) allows sensitometric controls in photographs made of the files. The wooden block is so angled with respect to the lens axis that 2 teeth represent 1 millimeter of depth. Three orders of detail can be photographed at various distances as shown by the composite prints; the coarse gray bands (a) at ⅓ scale; the network of the cuts forming the teeth (b) at 1 1; and the texture in the individual teeth (c) at 2/1 or larger. Notice that in (a) the gray bands are sharp, yet the network has *rounded* "holes". Also, the negative would not be suitable for enlarging to reveal tooth detail (see greatly enlarged small strip). In (b) the gray has become

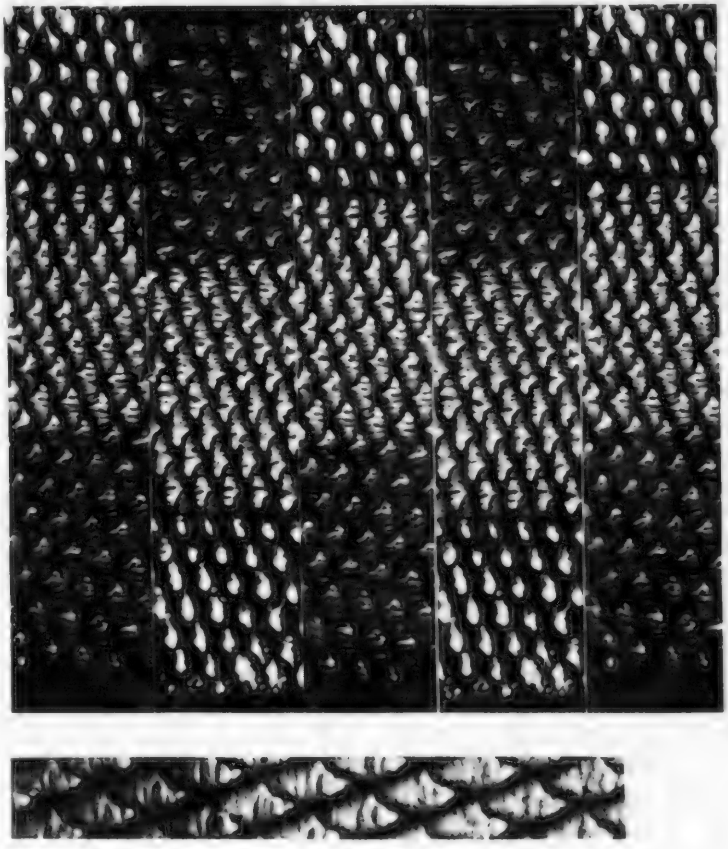


Figure A
(c)

Magnification at negative (m) was 2.0. Total magnification here (M) is 6.5. For strip (M) is 14.

so close as to be almost fuzzy, but the network shows the true "scalloped" *triangle* of the teeth (compare with a). However, the tooth-texture is not clearly revealed at this scale, nor is the negative entirely suited for further enlargement. To record the tooth-texture, a scale of 2/1 was adoped for the negative. Notice that each composite print appears sharp when viewed at the intended distance of 18 inches. The reason is that a satisfactory resolution of the *intended* order of detail has been made and textures finer than this are sharp enough even though inaccurate. A common lack of sharpness in actual insect photographs results from not realizing this effect. For example, the photomacrographer may attempt to show the scales on a moth's wings from a negative of the entire moth. Sometimes a negative is "over-blown" in this way through trying to produce a photograph of the moth from a negative of half the back yard.

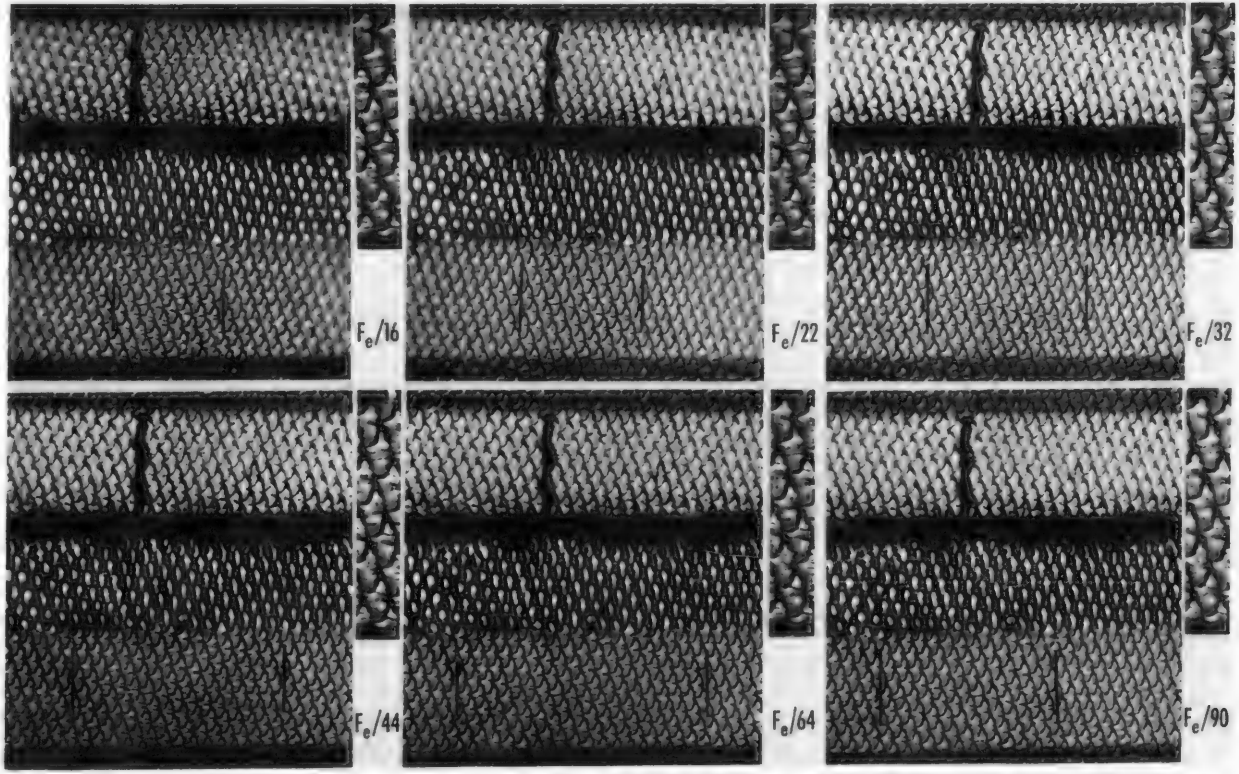


Figure B. This series, made at 1. 1 negative scale, shows how resolution and depth of field vary as the lens is stopped down. The lines show *where the author* would crop to remove fuzzy "wing scales" that are beyond the depth of field when the prints are viewed at 18 inches. The concept of depth of field is somewhat arbitrary. It will depend largely on what is considered an acceptable circle of confusion. The depth will vary as the viewing distance for the print changes and there is no sudden transition from sharp to unsharp. Since "perspective" in a photomacrograph is a somewhat meaningless term, a suitable viewing distance seems the safest way to establish conditions for judging the detail appearing in the print. In this latter respect personal standards will first play a large part; however, soon the photomacrographer will find the level of acceptable professional requirements. Thus, the viewer may not draw the lines where the author has; yet will probably follow the same trend. It will then be seen how resolution decreases as the lens is stopped down *(effective)* apertures are indicated) and how the depth first increases and then decreases. The tooth texture in the highlights (white band) represents the most critical detail. Total magnification (M) as reproduced here is 3.25, except for the strips where (M) equals 7.0.

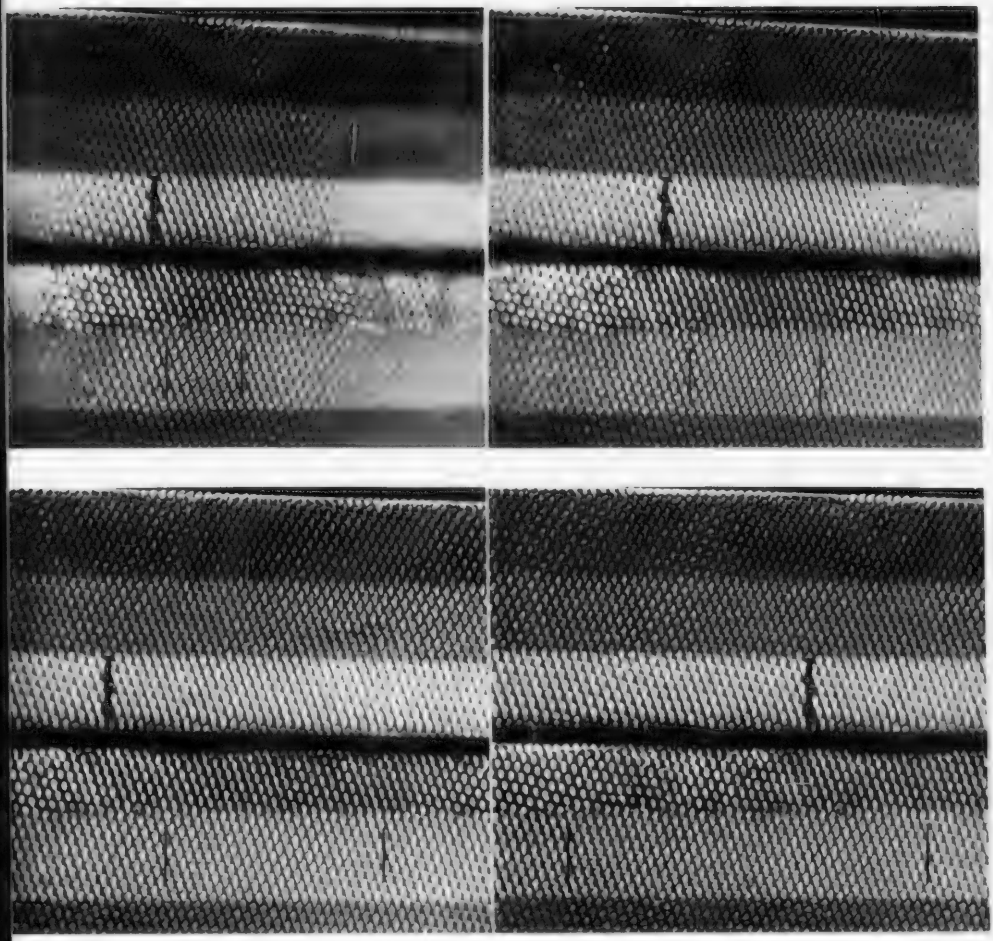
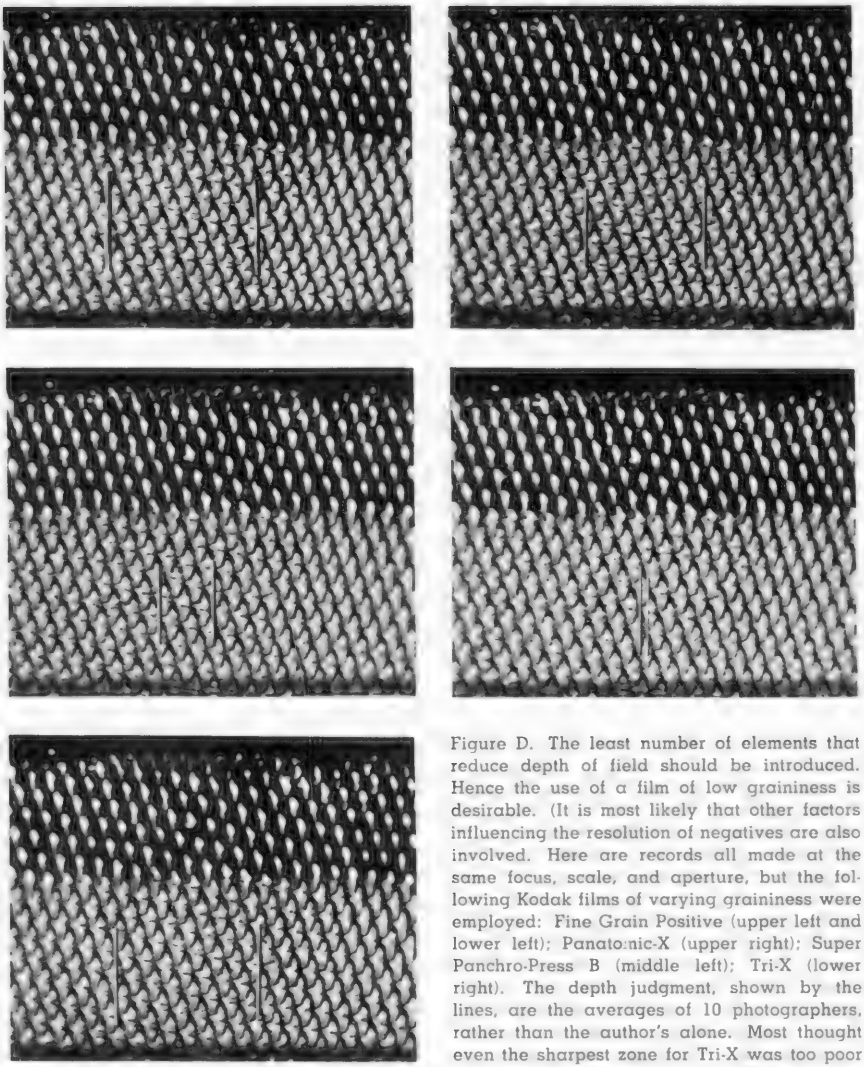


Figure C. One way to increase the depth of field is to reduce the taking scale, as shown here. However, if this is carried too far, factors such as the negative graininess interfere and overall definition suffers. Here the final image size has been achieved by enlarging from fine-grain negatives to a total magnification of 2.25. The negative scales were as follows: upper left 2.0; upper right, 1:0; lower left, 0:5; lower right, 0.333. The effective aperture was f/24 in all cases. As demonstrated in Figure A, the order of detail should be the major factor in deciding image size at the negative. Here the network is considered the object of interest. Quite often resolution and depth have to be juggled until the photomacrograph reveals the most that can be shown of the subject. The result is not always as elegant as an ordinary photograph and must not be judged on same basis. (In this series, plane of sharpest focus varied with each setup.)



Magnification at negative (m) was 0.5. Total magnification (M) as reproduced here is 4.5.

Figure D. The least number of elements that reduce depth of field should be introduced. Hence the use of a film of low graininess is desirable. (It is most likely that other factors influencing the resolution of negatives are also involved. Here are records all made at the same focus, scale, and aperture, but the following Kodak films of varying graininess were employed: Fine Grain Positive (upper left and lower left); Panatomic-X (upper right); Super Panchro-Press B (middle left); Tri-X (lower right). The depth judgment, shown by the lines, are the averages of 10 photographers, rather than the author's alone. Most thought even the sharpest zone for Tri-X was too poor to accept at this enlargement. The negative was printed twice with slightly differing contrasts. This was done to control quality variations in making the negatives and prints with regular equipment. While judgments varied by 4 teeth, the trend did not vary at all. The photographers possessed different degrees of proficiency. Viewing distance was 2 feet.

Photography of Large-Area Sections*

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TO show the overall organization of a histological section too large to photograph as a photomicrograph, one may resort to a relatively simple makeshift in which the size of section that can be photographed is limited only by the size of the film holder.

For example, to obtain a negative of a stained section of baboon placenta measuring 1¼" x 2" and mounted on a 2" x 3" slide, some modifications were made of a 3¼" x 4¼" *Graflex* film pack adapter and used in conjunction with a photomicrographic set-up, as illustrated in figures 1, 2 and 3.

Two pieces of clear glass were cut, each measuring $3\frac{7}{16}$" x $3\frac{3}{16}$" x $\frac{3}{32}$". One of these pieces "b", was used as a floor in the film holder between the emulsion cover "a" and the slide "c" to be photographed. The other glass plate "e" was placed over the cut film sheet to hold it flat against the cover-slip of the 2" x 3" histological slide. To avoid any shifting of the slide or emulsion, the rest of the space in the film pack adapter was taken up by several thicknesses of cardboard "f" and against this the 2 springs of the film holder cover were applied in closing. Thus, in order of assembly from bottom to top we have the emulsion cover, glass floor, microslide with cover glass side facing up toward the emulsion, emulsion side of cut film, second glass cover, cardboard packing and film holder cover.

Such an arrangement assembled in the dark room, may then be attached to the photomicrographic camera and a contact natural size "photomicrograph" of the section taken. Figure 1 presents a photograph taken with an *Argoflex* camera of a contact print made from the contact negative taken with the "photomicrographic" set-up described. A combination of X-1 and B-58 green filters was used in conjunction with a 15X ocular and 21X objective. Three foot-candles were registered and the exposure was made for 8 seconds.

Placing the cover glass side of the slide against the emulsion leaves only that distance between the section and emulsion represented by the thickness of the cover glass, thus making for a negative of good definition. The negative taken can be used on the enlarger to make a picture of any desired size. The method outlined may be of value in the preparation of natural size negatives and positive transparencies (for projection slides) of whole brain and cord sections or slides (thin enough to transmit light to the film emulsion).

A suggestion is made whereby one may modify a film pack adapter in such a way as to make contact negatives of

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histological sections too large to photomicrograph. The mounted slide is secured against the emulsion in the film pack adapter and an exposure is made with the standard set-up for photomicrography. From the resulting natural size contact negative, any desired size of positive enlargement may be made, if the contact print is too small to show histological organization. The size of tissue section which can be reproduced is limited only by the size of the film pack adapter. Even whole brain slices may be "photomicrographed".

KEY TO LABELS

(A) Emulsion cover

(B) Glass floor

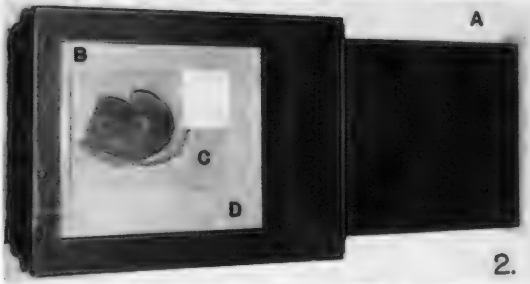
(C) Stained slide

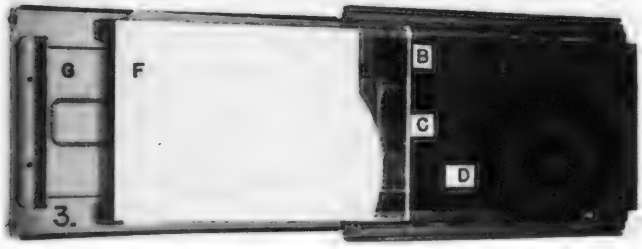
(D) Emulsion side of film

(E) Glass cover on film

(F) Filler packing of cardboard

(G) Cover on film holder





Figures 1, 2, 3 and 4. Figure 1 is a photograph of a print made from the contact negative of a whole placental slice measuring 1¼ in. x 2 in. Figure 2 is a view of the film pack adaptor loaded ready for contact photography with the emulsion cover pulled out. Figure 3 presents the film pack adapter open with the various items to be assembled. Figure 4 illustrates the entire "photomicrographic" assembly ready for use.

Journal of the Biological Photographic Association Vol. 22, No. 3 August, 1954

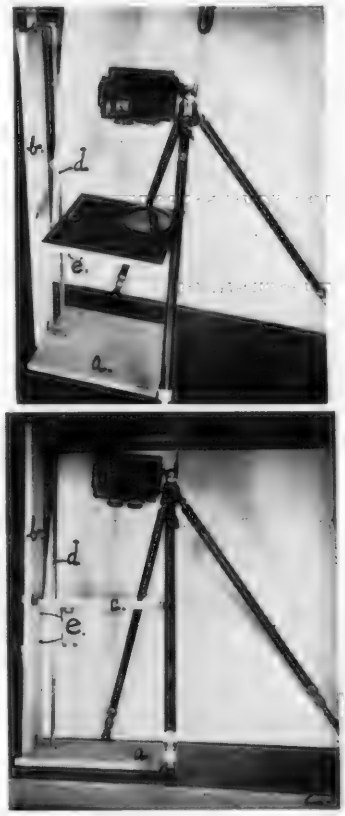
Adjustable Platform for Photography*

HOWARD H. HILLEMANN

Department of Zoology, Oregon State College, Corvallis, Oregon

IN the photography of small whole objects such as embryological specimens when using a camera fitted with a portrait lens for close-up shots, it may be necessary to adjust the object up and down to bring it into sharp focus. Stacking books for this purpose is both clumsy and does not allow for fine adjustment.

The accompanying figures 1 and 2 are views of an adjustable platform which can be made easily and quickly. Platform "c", measuring 8½" x 9" x ½" and moored to the adjustment spring and platform support "e" is capable of fine adjustment up and down the vertical rod "d" which measures 26" in height and ⅜" in diameter. In addition this platform may swing through an arc of 60 degrees to either the right or the left for convenient adjustment in relation to the tripod mounted camera. The vertical rod "d" is moored both above and below by angle irons, to the vertical board "b" (26" x 3" x ½") which in turn is anchored to the base board "a" (8½" x 10½" x ½") by two screws. The lower angle iron serves as a brace to maintain rigidity and a 90 degree angle between the base "a" and the vertical board "b".



Figures 1 (above) and 2 (below). Views of adjustable platform. Key to labels (a) base, (b) vertical board, (c) adjustable platform, (d) vertical rod, (e) adjustment spring and platform support.

Summary

The design and construction of a simple and conveniently adjustable platform is described for bringing objects into sharp focus.

* Received for publication May 24, 1954

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PORTFOLIO

OF

OUTSTANDING

BIO-PHOTOGRAPHS

AND

PHOTOMICROGRAPHS

BY

MEMBERS

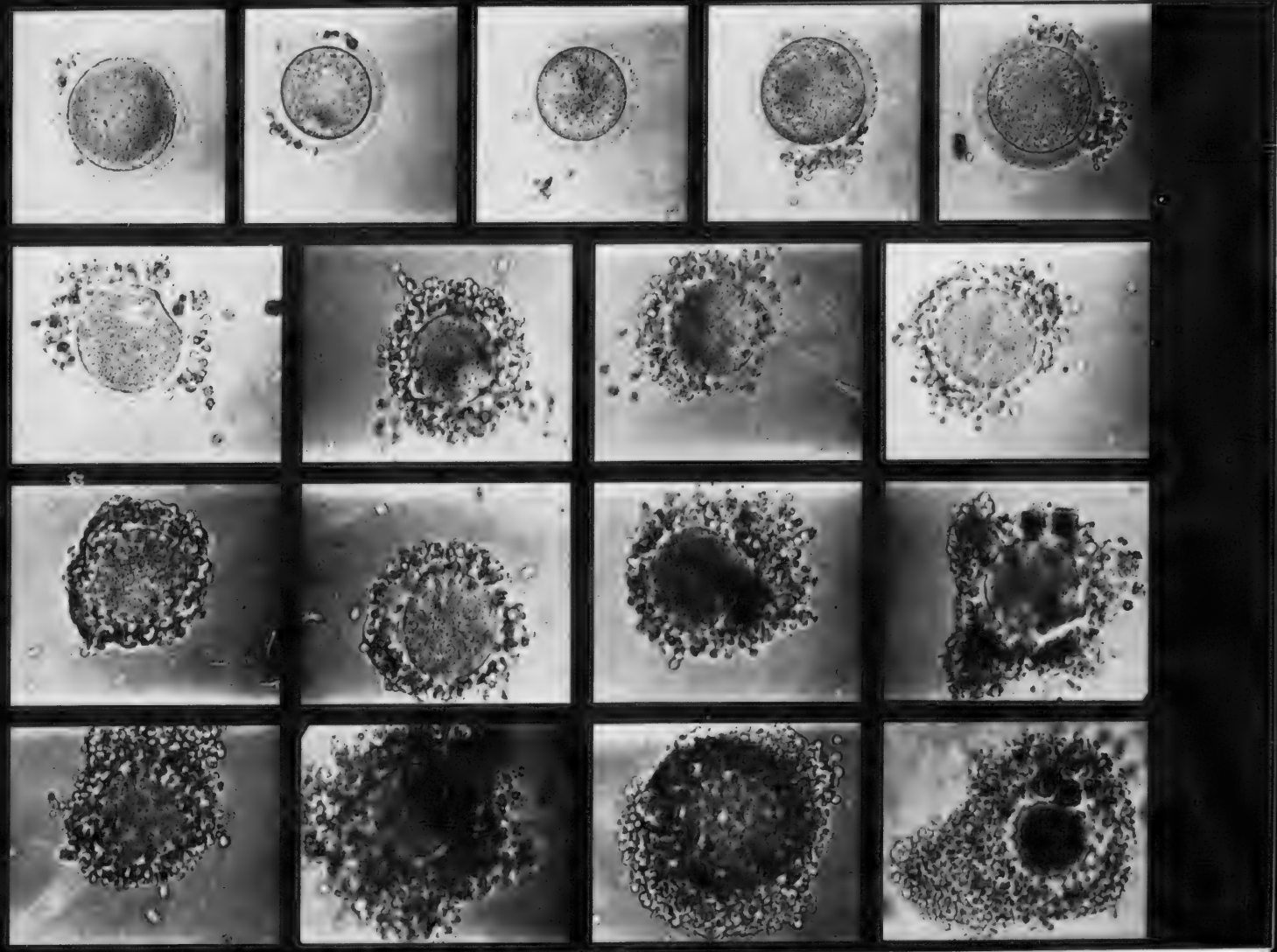
OF THE

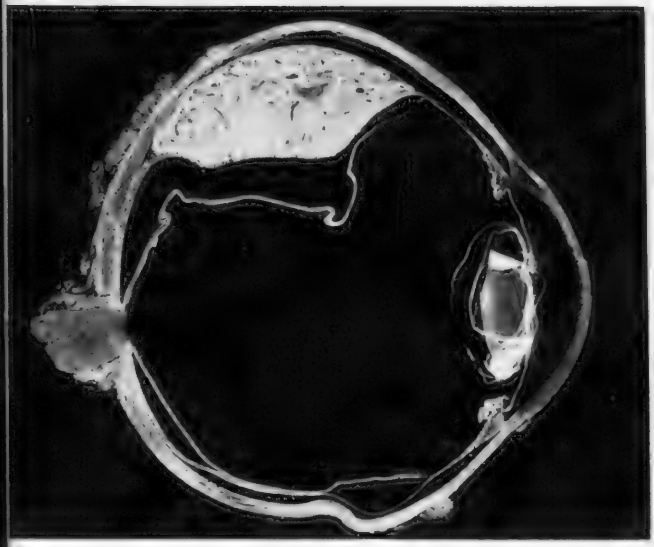
BIOLOGICAL PHOTOGRAPHIC ASSOCIATION

ON THE FOLLOWING PAGES, BEGINNING PAGE 115, ARE REPRODUCED A COLLECTION OF OUTSTANDING EXAMPLES OF BIO-PHOTOGRAPHS AND PHOTOMICROGRAPHS, NONE OF WHICH HAS BEEN PUBLISHED BEFORE. THE EDITOR REGRETS THAT ONLY A LIMITED NUMBER OF THE MANY PRINTS SUBMITTED FOR THIS PORTFOLIO COULD BE ACCEPTED FOR PUBLICATION. NOT ONE PRINT, HOWEVER, WAS REJECTED BY THE SELECTION JURY BECAUSE OF POOR PHOTOGRAPHIC QUALITY. THIS ATTESTS OF THE HIGH STANDARDS OF BIOLOGICAL PHOTOGRAPHY UPHELD BY MEMBERS OF BPA

LARDNER A. COFFEY, FBPA Mayo Clinic, Rochester, Minnesota

Cavernous, capillary hemangioma of the left leg extending from the lumbar region to the toes. This congenital defect is characterized by the extensive venous pattern seen in the above infrared photograph.





Print from a negative plate

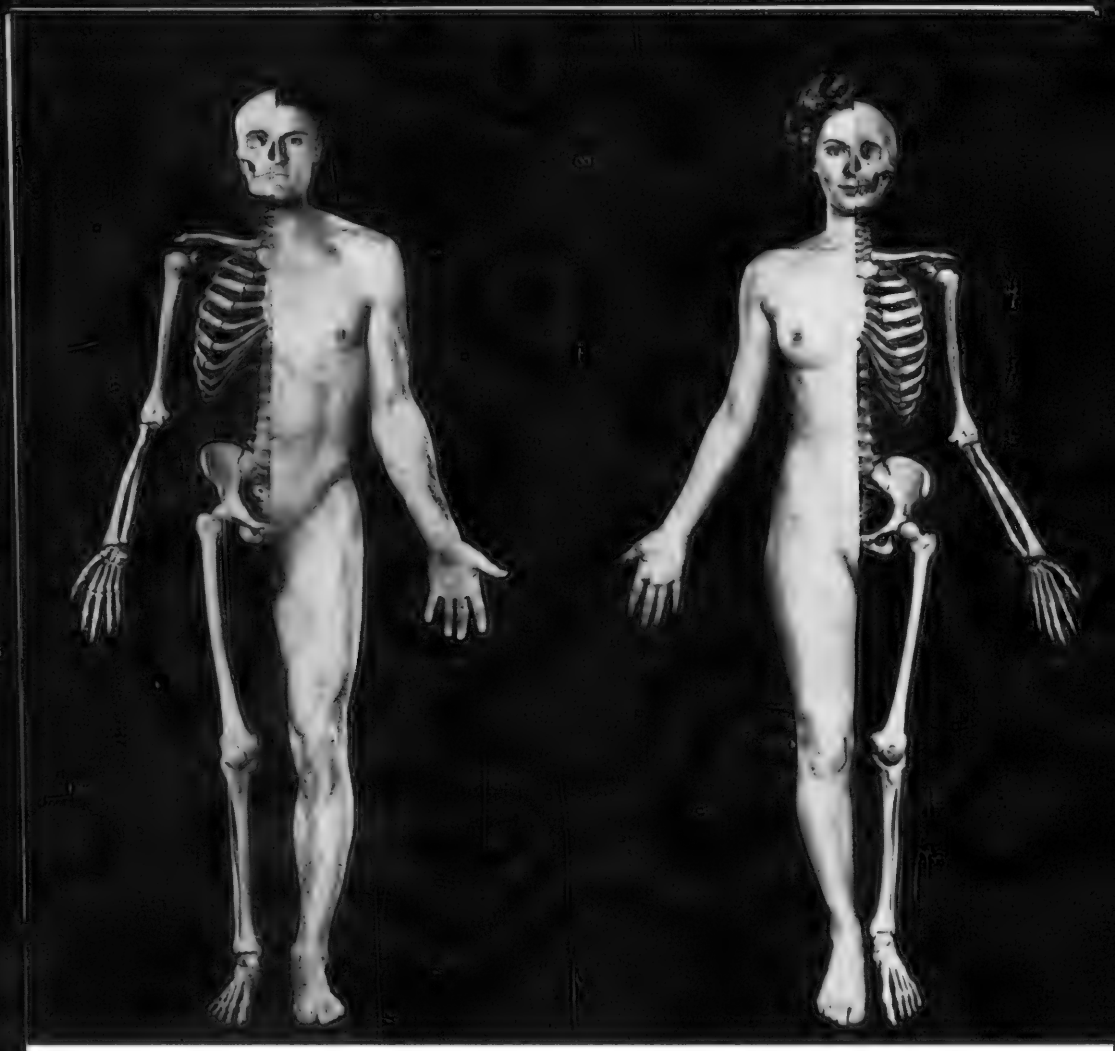
F. C. BRECKENRIDGE,
Baylor University, College of Medicine, Houston, Texas

Print from a positive print

Carcinoma of lung, metastatic to eye. More structural detail is often seen in a negative print.

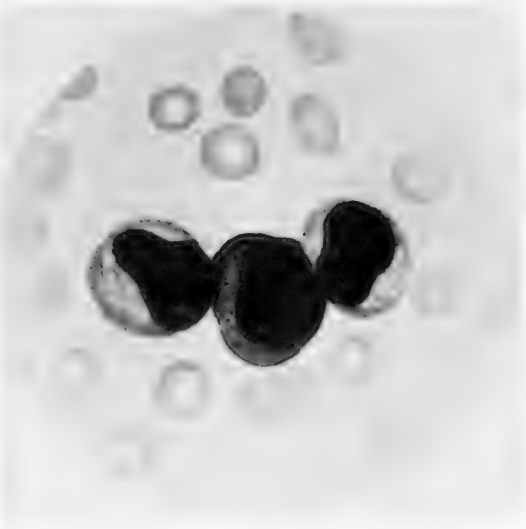
← DR. EDMOND J. FARRIS, FBPA, DR. WARREN H. LEWIS and HAROLD BAITZ
The Wistar Institute, Philadelphia, Pennsylvania

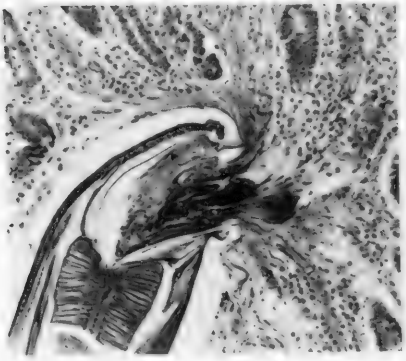
Seventeen human ova from follicles in human ovary. Several have only few corona cells on the edge.



H. LOU GIBSON, FBPA — Eastman Kodak Company, Rochester, N.Y.

Anatomical comparison showing male and female skeleton and habitus combinations.



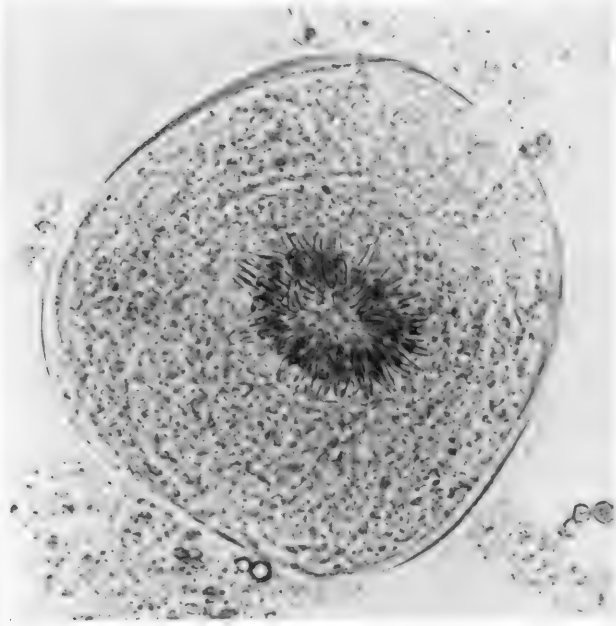


Photomicrograph — Nematode-Hookworm biting wall of small intestine.

Photomicrograph — Acute myeloblastic leukemia.

STELLA ZIMMER, FBPA and LOUIS GEORGIANA

State University of New York at Syracuse University



Photomicrograph—Scolex of taenia echinococcus showing hooklets. Found in echinococcus cyst of liver.

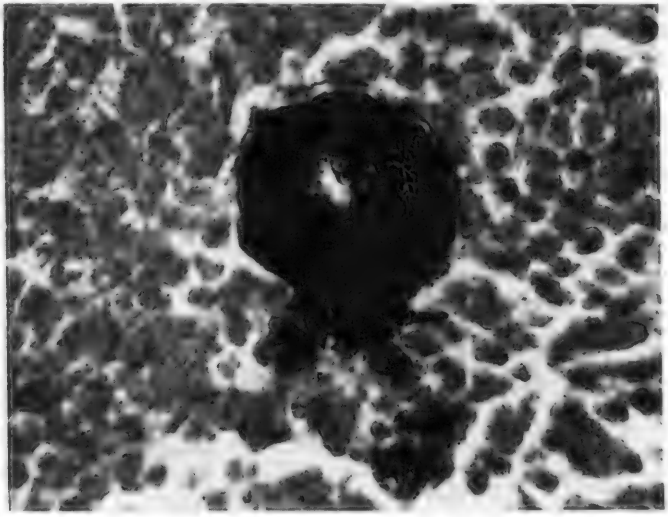
ALBERT LEVIN, FBPA and
JAMES STARK

The University of Pittsburgh, Magee Hospital, Pittsburgh, Pennsylvania

Ear lobe returned after traumatic avulsion.

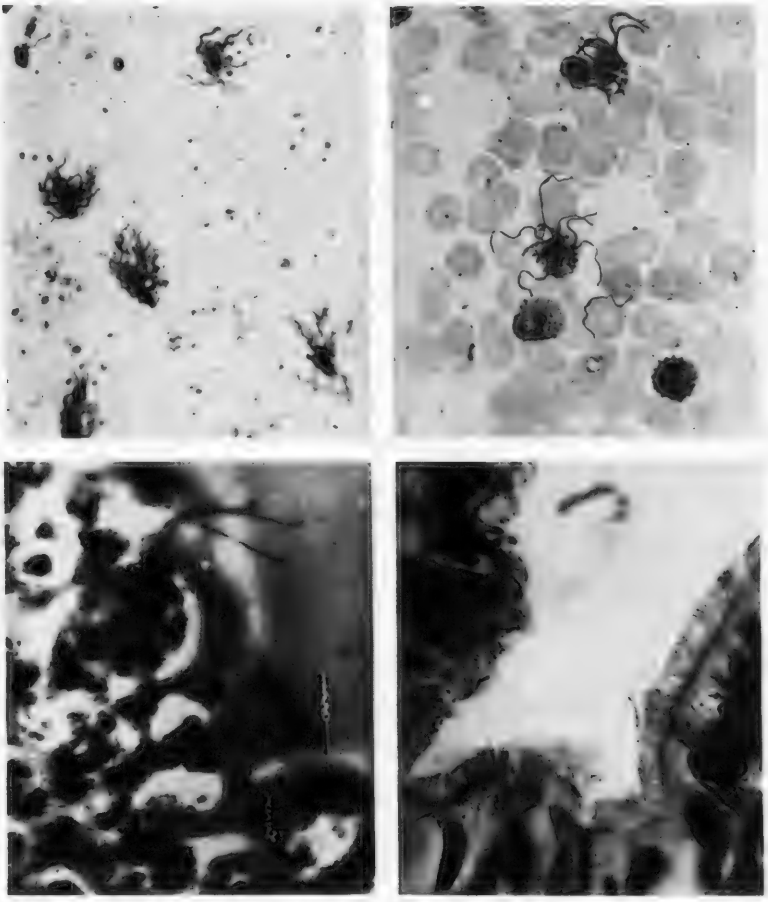
Early cancer of the breast.

LLOYD MATLOVSKY University of Southern California, Los Angeles General Hospital, Los Angeles



Organism found in coccidioides immitis which ruptured and liberated packed endospores. Reproduced from a dye transfer color print.

AVIS GREGERSON, FBPA
University of Southern California, Los Angeles, California



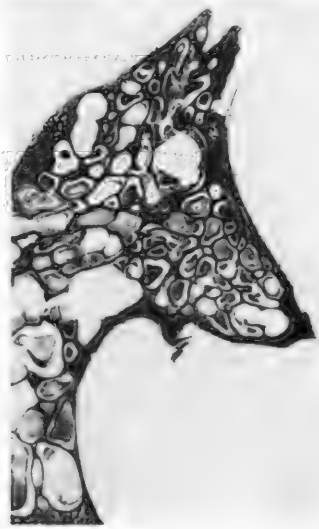
JULIUS WEBER Riverdale, New York, N.Y

Methods of Movement in Living Cells — This series portrays four different living cells and their response to the need for constant action and movement. Here nature again illustrates her unique creativeness and frugality in the reuse of sound principles. Despite the steadily increasing complexity observed in the rising scale of cellular structure — from the most simple single cells to involved multicells — their similarity in chemical composition and physical structure is astonishing.

The smallest here is the typhoid bacillus (upper left). Living in a gently moving stream, it favors (as does the college varsity crew) the rhythm of the centipede. The malarial parasite (upper right) preys upon countless, free swimming cell victims in a swiftly moving stream, resorting to a structural advantage not unlike that of the octopus, which is the parasite's "shapesake" at a scale of about 100,000 to 1. Life for the tiny trichomonas, (lower left), on the other hand, entails one interruption after another. Enjoying a lone-wolf existence in a less placid fluid (where things can happen suddenly) it is geared to zoom away from harm as if propelled by an outboard motor. But the poor cell of the epithelium (lower right) even though bound in by thousands of its neighbors, is not to be outdone in the quest for movement. Each cell extends its protuberences, and together form a long, community column of dancing, waving cilia along passages in the body.

CHARLES M. BAILEY St. Mary's Hospital, Rochester, N.Y.

Hypermature cataract delivered spontaneously through corneal perforation due to a pseudomonus aeruginosa infection. Original on 35 mm color film. Reproduction from a black-and-white print of color transparency.



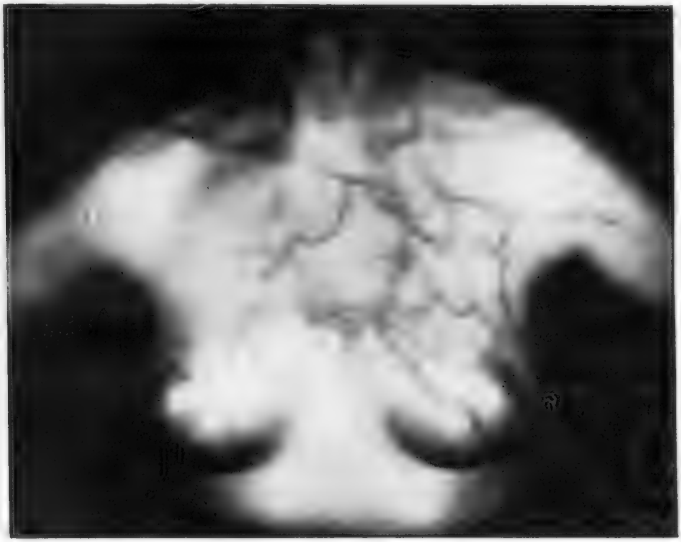
MARIA IKENBERG, FBPA
University of Illinois, Chicago, Illinois

Humorously entitled "Doggone Human Acute Mastoiditis", from Dr. M. J. Tamari collection.

WILLIAM J. TAYLOR, FBPA

Temple University School of Medicine, Philadelphia, Pennsylvania

Left photograph shows Hemangioma. Right, same person 18 years later after treatment, demonstrating value of retaining negatives in file.

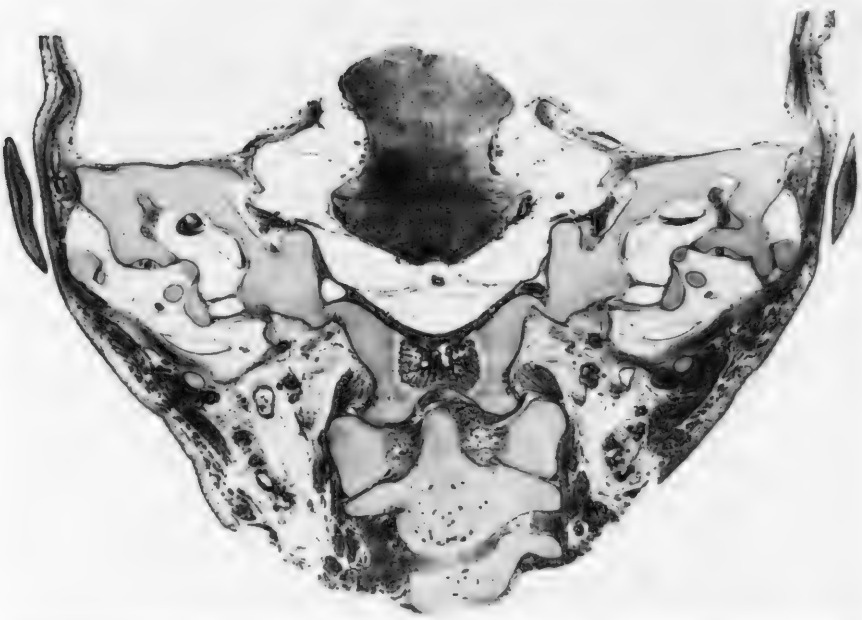


LEWIS W. KOSTER Columbia University, New York, N.Y

Infrared photograph showing considerable engorgement of superficial venous circulation on left side. No unusual venous pattern seen when viewed by visible radiation.

LESLIE E. HIER University of Chicago, Chicago, Illinois

Severe rheumatoid arthritis.

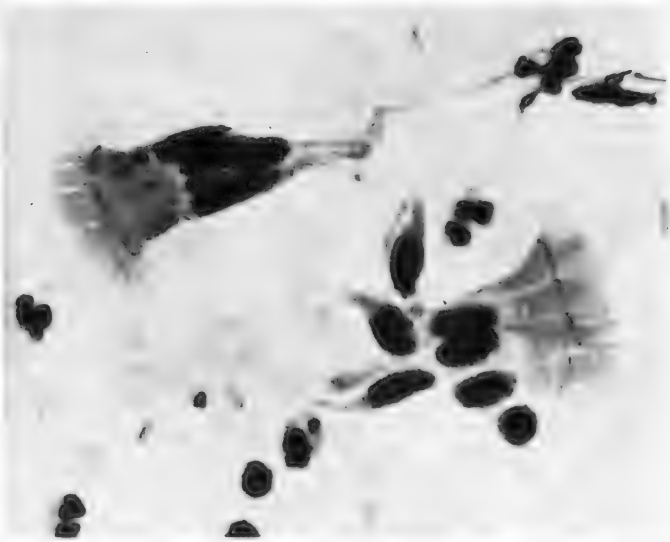


MARIA IKENBERG, FBPA University of Chicago, Chicago, Illinois

Ear development of newborn dog.

JAMES B. GLAZE University of Chicago, Chicago, Illinois

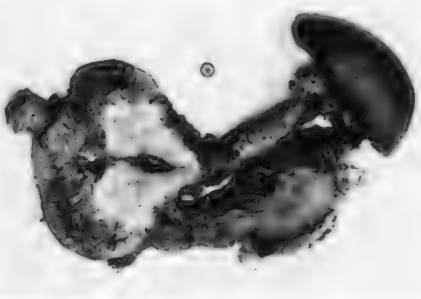
Celloidin preparation of human cochlear area (8X), illustrating use of high contrast film (Kodalith Ortho Type II) for very low contrast subjects.



STANLEY J. McCOMB, FBPA Mayo Clinic, Rochester, Minnesota

Ciliated epithelial cells. Original magnification 700X.

Aortic transplant. (Reproduction revolved 90°).



Carcinoma of pancreas.

Surgical field photograph *(above, left)* by ROBIN WHITE.
Gross specimen photograph by R. B. SOUTHWORTH.

Veterans Administration Hospital, Houston, Texas

Journal of the Biological Photographic Association Vol. 22, No. 3 August, 1954

Image Distortions with Illumination at Small Angles of Incidence—III

CHARLES HALE

Dominion Museum, Wellington, New Zealand

Introduction

BESIDES perspective distortions, which depend on the position of the specimen in relation to the lens, and illumination distortions, which are caused by the difference between the positions of the lens and light source in relation to the specimen, there are two further distortions, namely, that caused by changes in the relationship between the equivalent monochrome tone values of the specimen and the tone values of the print, and that introduced into the image by illumination arising from the background, which is a secondary light source.

The background should be of such a tone that the specimen is clearly defined and cannot be confused with the support. The widespread use of oblique light has led to the use of transilluminators in which light from an auxiliary source is projected from behind the specimen through a translucent support. While filling the cast shadows, this light also increases the intensity of the background as a secondary light source and, as we shall see, aggravates the effects of interference reflections. It has been found that if the angle of incidence of the illuminating beam is small, auxiliary means for increasing background brightness are rarely required. Since we are concerned with *print* background whiteness, and since this is influenced by contrast control during processing, it is necessary first to examine the tonal distortions which arise in the transference of a group of tones from specimen to print.

Whiteness

The photographic print combines two effects: it is a translation into monochrome of colors, and it is a record of light intensities arising from reflections of the light source at the specimen surface. These two effects are commonly referred to as the "luminance scale"* of an object. Clearly, the "color scale" lies between white and black, the value of any one color being an absolute value and occupying a constant position in this scale at a constant and known distance from either extremity. The length of the "light scale," on the other hand, is relative to the intensity of the incident light, at one end being *darkness* (a constant and absolute minimum) and at the other the light source intensity. Hence the tone value of the specular component of a specimen shifts away from the darkness end of the scale as the light source intensity is increased.

*See reference note at the end of paper, page 132.

* Received for publication June 15, 1954. Parts I and II of this series appeared in Vol. 22, No. 1, pp. 1-14.

The print has a scale of absolute tone values, the extremities of this scale being determined by the whiteness of the paper and the maximum blackness of which it is capable. The "print scale" is shorter than the "color scale" since the whitest paper is not so white as, for example, magnesium carbonate whose reflection factor is given as 0.97, nor its black so non-reflective as black velvet (0.004). Thus the three scales may be summarized as follows:

Color Scale—absolute values — Range: blackness to whiteness.

Light Scale — relative values — Range: darkness to light-source intensity.

Print Scale — absolute values — Range: black paper to white paper.

Object whiteness extends in the "color scale" from magnesium carbonate (0.97) down to white cloth (0.3), a difference of 0.67. The difference between white cloth and black paper (0.05) is 0.25, and between black paper and black velvet 0.046. Thus the "color scale" is seen to consist of three groups of equivalent monochrome tones the tonal distances of each group being:

Whites: 0.67; Grays: 0.25; Blacks: 0.046.

Thus there is a progressively increasing difference between tones from black to white, and therefore it should not be difficult to find white background materials which reproduce whiter than the whitest specimens.

The length of the "light scale" is greater than that of the "color scale" since there must be an extension to include the brightness of specular reflections when these are brighter than absolute white, and another extension at the opposite end to include shadows when these reflect less light than the blackest tone of the tone group being photographed.

Tone Separation

Since the "print scale" is the shortest of the three, a print can contain only part of the full "color scale"; the other tones being shifted towards one or both extremities. A contrasty paper tends to separate tones, pale grays towards white, dark grays towards black. The opposite effect is found with soft papers which shorten tonal distances and can therefore encompass a greater range of the tones in the negative. The visual effect of tonal compression is muddy and unsatisfactory for illustration.

If tonal separation as a process is to be exploited successfully negatives must be of such a nature that their essential linear elements should belong to closely associated tone-groups; otherwise as in normal negatives, when the linear element is reproduced by extremes of highlight and shadow, the elimination of such extremes leads to partial losses of outlines and contours. For instance, tones resulting from variations in the reflection of light through the specular factor, and tones resulting from shadow effects, must be carefully controlled and arranged in such a manner that no essential linear elements are represented by the tone-groups. When a specular surface reflects light from a small source of known distance, size and angle of incidence, or when shadows are eliminated from the negative image and illumination is either uniform or symmetrically non-uniform, tonal separation is free to act solely between the absolute tones of the specimen. It may then be fully exploited even so far as to separate closely associated tones like blacks, and to such an extent that of two blacks the less black will print white.

If a shadow is cast on black paper the shadow will appear darker to the

eye than the illuminated paper. How much darker depends on the intensity of the incident light and on the amount of light reflected into the shadow by adjacent light reflectors. Now as the blackness of an object is by definition an absolute value, and the darkness of a shadow a relative value, it should be easy by tonal separation methods to differentiate between blackness and darkness so that the former prints white and the latter black. Since the final effect of a reflection of no-light is the same as a no-reflection of light, the curvature of a spherical object, by eliminating the reflection of light from its periphery, will provide the equivalent of a cast shadow, but in such a way that the gradual diminution of reflection may be observed.

Figure 12. Mat black sphere on mat black background.

Figure 12 is a photograph of a matt-black sphere on a matt-black background made on an ordinary process emulsion developed in D-72, 1:1. In this figure the whole of the image tone difference between dark gray and white is due to the difference between darkness and blackness in the original. Hence, under certain conditions, it is possible to obtain a white background from a black original. It shows also that groups of tones in the "color scale" may be shifted to the opposite end of the "print scale" by tonal separation, and that a secondary light-source can function successfully as a white background although at minimum intensity.

This figure does not show how two adjacent tones somewhere in the "color scale" may be represented at opposite ends of the "print scale". This may be proved by a simple experiment. Take a strip each of black velvet and matt-black paper, illuminate them uniformly with axial light, expose a process emulsion eight times longer than for white paper and develop it for three or four times normal in D-72 or similar developer. Of the two images obtained, one will be markedly denser than the other. If this is true of the blackness end of the "color scale" where tonal distances are less than elsewhere, then it must be true also of the rest of it.

The Background as a Secondary Light Source

Illumination distortions have hitherto been discussed as a function of the primary light-source — a point source of light vertically incident upon the object surface, which has been either curved or plane, and symmetrically placed about the optical axis of the lens. The images of this light source due to specular reflections have not been considered as a distortion, in fact their locations on surfaces usually help to define specimen structure. However, when light is incident on a specular surface other than from this primary source, and its origin is of unknown

area, shape, position and distance, these reflections, by making a major contribution to the image, especially of dark specimens, largely determine the nature of the image. This secondary light source is the background. It will be shown that, in the extreme case of a black specular sphere on a white background, the image obtained is mainly an image of the background distorted by the curvature of the sphere.

Given a black specular sphere, the reflections at its surface are of a secondary light source and are inverted images in that the more distant background points are mirrored nearer the axis while the nearer points are mirrored about the periphery. Reducing distant background areas does not diminish reflections near the critical edge image rays, and because these reflections neutralize the no-reflection effects of axial lighting and soften contrasts between object-outline and background, it is necessary to seek means for counteracting interference from background brightness. There are four problems: (1) to find at what points on the sphere the background reflections are formed; (2) from this the area of reflections for given background areas; (3) how reflections are affected by the curvature of the reflecting surface; (4) the ratio of image dimension to reflection dimension as a function of surface curvature.

Reflection Positions and Areas

For a black specular sphere symmetrically placed for perspective and illumination and for which the light source is virtually in the same position as the lens, making $\theta_s = \theta_z$, the positions and sizes of reflections may be calcu- given only lens/background distance (Z) and the sphere's radius of curvature (R). In Figure 13, where θ_z is the

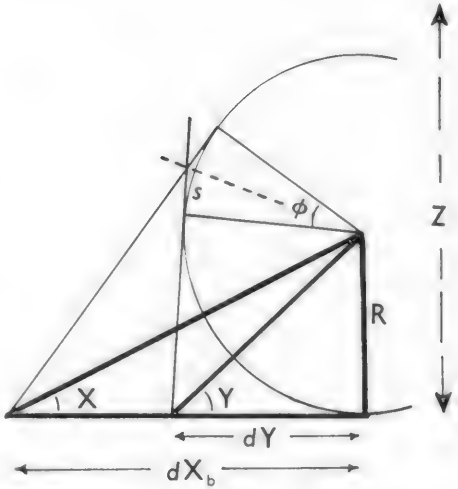


Figure 13. Calculating the sizes and positions of background reflections on a specular sphere.

angle subtended at the lens by the radius:

$$\sin \theta_z = R/Z = R:$$

dY is the distance, on the background plane, from the optical axis of point Y (the position of the edge image ray):

$$dY = \tan \theta_z:$$

Y is half the angle subtended at the lens by dY:

$$Y = 1/2\ (90^\circ - \theta_z):$$

dX_b is the distance on the background plane between a given point X and the optical axis, and angle at point X is subtended by:

$$\cot X = dX_b/R:$$

ϕ is the central angle subtended by tangents from X and Y:

$$1/2\phi = Y - X:$$

s is the arc subtended by $1/2\phi$:

$$s = R\ [1/2\ (90 - \theta_z - \cot X]_r$$
$$R \cdot 1/2\phi_r \quad \ldots\ldots \quad (1)$$

From equation (1) positions and areas of reflections on the sphere for a series

of background points may be calculated (see Table II) and plotted graphically to illustrate the relationship $s(f)dX_b$ for given values of dX_b, Z and R. Such a curve is shown in Figure 14 when R = 1 cm, Z = 58.3 cm, and the ratio of the coordinate scales x:y is 1:100. It will be seen that the rate of increase for s diminishes progressively more slowly as dX_b approaches infinity and the angle at X approaches zero.

Only part of the arc s, however, has an image dimension, namely that part which is laterally displaced in relation to the lens. So the image dimension of s depends on two factors: the actual length of the arc, and its position on the sphere. When the lateral value of s is related to the edge image ray it is required to find the proportions of image dimensions to lengths of arcs for given values of the central angle. If the image dimension of s is *di* (Figure 15), then:

$$di = R - R\cos\tfrac{1}{2}\phi = \mathrm{vers}\tfrac{1}{2}\phi \quad \ldots \text{(ii)}$$

From equation (ii) it is found that the values of *di* are lowest where those of s are greatest, hence the relative shal-

dX_b	$\frac{1}{2}\phi$	s (mm)	di (mm)	β	$I\cos\alpha_2$
1.02	00° 05′	0.0145	0.000011	00° 00′ 0.23″	9.998
1.05	00 54	0.1571	0.001234	00 00 24.6	9.988
1.1	02 14	0.3898	0.007596	00 01 57	9.955
1.2	04 42	0.8200	0.033626	00 10 18	9.841
1.3	06 56	1.2101	0.072776	00 21 40	9.681
1.5	10 49	1.8879	0.177673	00 46 24	9.281
2.0	17 57	3.1329	0.486742	01 38 05	8.063
4.0	30 28	5.3174	1.380757	02 15 04	5.048
5.0	33 12	5.7945	1.632357	02 05 58	4.179
6.0	35 03	6.1145	1.813488	01 54 52	3.553
8.0	37 23	6.5217	2.054087	01 35 29	2.727
11.0	39 18	6.8591	2.261598	01 14 05	2.017
13.0	40 07	7.0017	2.352660	01 05 26	1.712
16.0	40 56	7.1442	2.445276	00 54 26	1.400
24.0	42 07	7.3508	2.582192	00 38 05	0.942
32.0	42 43	7.4551	2.652827	00 36 39	0.729
50.0	43 22	7.5673	2.730257	00 19 02	0.454
64.0	43 36	7.6096	2.758281	00 15 59	0.360

Table II. Values of *s*, *di* and I_{α} ref as functions of dX_b in Figure 14, for which R = 1cm, Z = 58.3cm.

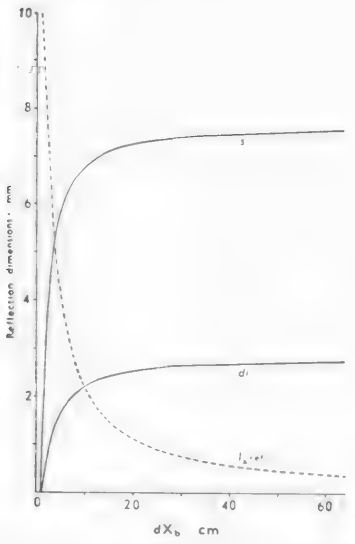


Figure 14. Graphs showing the actual sizes and image sizes of reflections on a specular sphere, and the luminous intensities of these reflections.

lowness of the curve of *di* in Figure 14. It appears that although background reflections attain their greatest magnitude adjacent to edge image rays it is here also that they have their smallest image dimensions per unit of arc.

The problem being to find by what amount dX_b can be greater than dY without appreciably affecting the peripheral image, it is instructive to examine a photograph of a specular black sphere on a white background (Figure 16). For this picture, illumination was an axial circular cone of light of radius 16cm, uniform except for a bright outer fringe 2cm wide. In direction A the background was masked by black paper laid at right angles to the A direction at a distance of 2.73cm from the optical axis. In the opposite direction (B) the cone of light itself was masked, the mask shadow being parallel to mask A and distant 13cm from the optical axis. By inspection of the image in the focussing screen it was judged that mask A eliminated all background reflection. The photograph shows that the fringe reflection is interrupted in both directions, whereas it appears that the whole of the background reflection in direction A is absent.

Substituting in equation (i) when radius of the sphere is 2.1cm and the lens/background distance is 39.1cm, $s = 2.2$mm; and in equation (ii), di 0.114mm. Thus there should be a peripheral area 0.114mm wide beyond the apparent outline in the photograph. An enlargement (Figure 17) reveals the presence of this area as a gray tone, the negative density of this area being

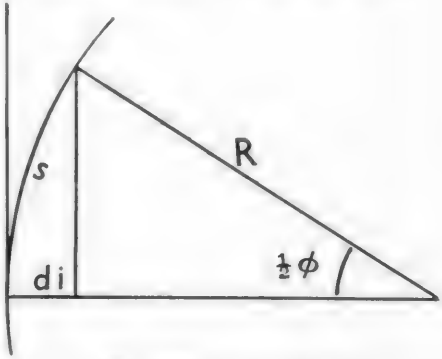


Figure 15. The relation of actual size (*s*) to image size (*di*) of reflections on a specular sphere.

such that when a more contrasty print is made and the background registers white this area merges into the background tone. Therefore the image in Figure 16 does not represent the real dimension of the sphere, being too small in diameter by 0.228mm x 1.0625 = 0.2423mm, where 1.0625x is the magnification factor of the negative.

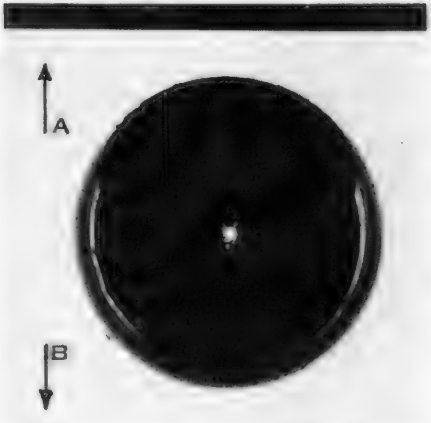


Figure 16. Specular black sphere photographed on a white background.

Not only is the apparent diameter of the sphere reduced by secondary light-source reflections but the outline position is made vague. Figures 16 and 17 show that in a normally exposed and developed negative this area does not appear in the print because it is overexposed in relation to the background. It should be possible, by exposing for the background and using tonal separation, to shift the group of gray reflection tones as a whole towards the black end of the scale and thus create a tonal gap between the palest peripheral reflections and the adjacent background. This would be simple if the reflection tone group were uniform and derived from the "color scale," but brightness increases towards the periphery, so that the apparent position of the periphery in the print depends partly on the depth to which the image is printed. The darker this is carried the further outwards the periphery moves until a point is reached at which neither periphery nor background print white. To ascertain the possibility of separating background and peripheral reflection tones it is first necessary to investigate means for calculating, and then relating luminous intensities of background points and reflection points.

Reflection Intensities

The luminous intensity of a ray of light reflected from the background and incident at a point on the surface of a specular sphere may be calculated by using Lambert's Law. This states that the luminous intensity of a point on the surface of a perfect diffuse reflector decreases as the reflection angle increases according to the equation: $I_\alpha = I \cos \alpha$.

Figure 17. Enlargement of Figure 16 to show preipheral area, in direction A, of gray tone.

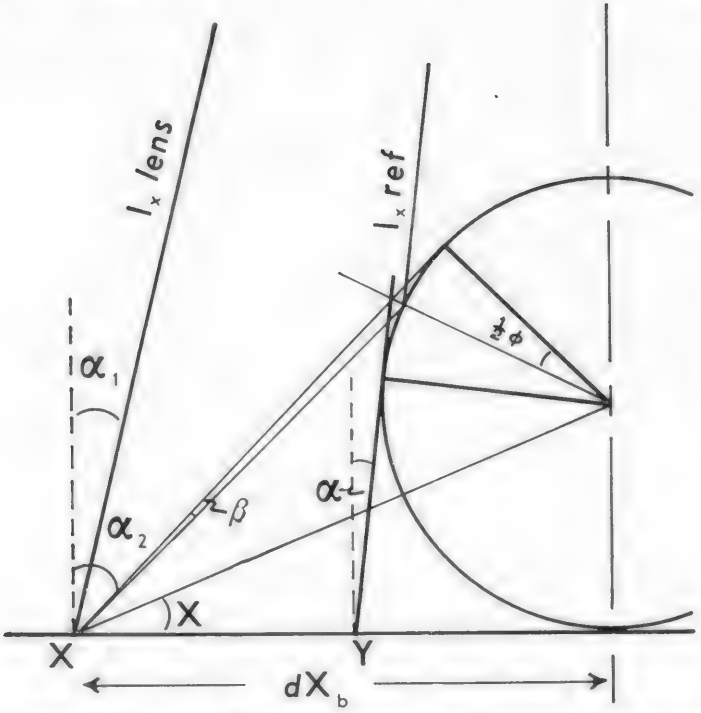


Figure 18. Calculation of reflection intensities for background points, and reflection points on a specular sphere.

where I_x is the luminous intensity of the reflected ray, and a is the angle of reflection. Referring to Figure 18, the luminous intensity of a background-point X at the reflection-point on the sphere ($I_x$ref) is a function of the complement of twice the angle at X, less the angular difference (β) between $I_x$ref and the tangent to the sphere (dX_t). Where a_2 is the complementary angle:

$$a_2 = 90 - (2 \cot X + \beta).$$

Figure 19 shows that angle β is subtended by a perpendicular (d) from dX_t to the reflection-point, so that:

$$\tan \beta = d/(dX_t - h), \text{ where } h = R \sin {}^1\!/_2\phi, \text{ and } d = R - R \cos {}^1\!/_2\phi = \text{vers} {}^1\!/_2\phi.$$

Therefore:

$$I_x\text{ref} = I \cos a_2 \quad \ldots\ldots \text{(iii)}$$

As the lens forms two images of every background point except Y, one by reflection in the sphere and one directly into the lens, and the direct ray's luminous intensity is I_x lens, Figure 18 shows that:

$$I_x\text{lens} - I_x\text{ref} = I \cos (a_1 - a_2) \quad \ldots \text{(iv)}$$

The maximum luminous intensity of any background point is found at Y, where it is less than that for the normal to the surface by I cos a, where $a = \theta_z$, making:

$$I - I_y\text{lens} = I \cos\theta_z.$$

When the luminous intensity of $I_x$ref is related to that of $I_y$lens their difference may be expressed:

$$I_y\text{lens} - I_x\text{ref} = I \cos (\theta_z - a_2) \quad \ldots \text{(v)}$$

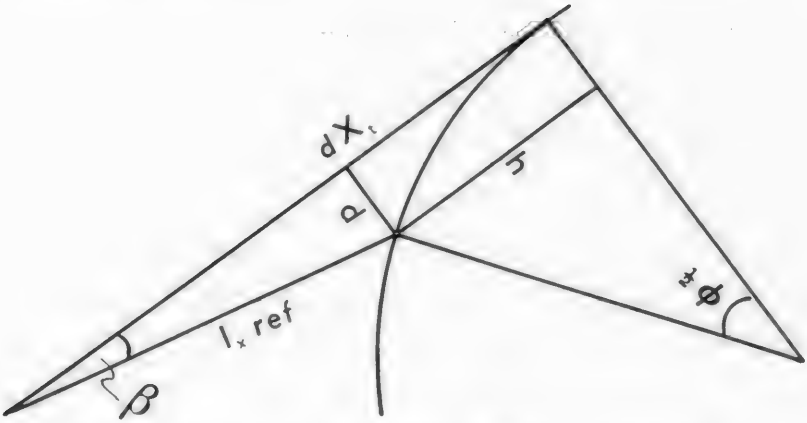


Figure 19. Calculation of the angle between reflection point and tangent.

By substituting in equation (iii), a series of values for $I_x$ref for a series of background points may be obtained (see Table II), and these values are given as a dotted curve in Figure 14 to show how rapidly the intensity of background area reflections falls off for a background area roughly ten times the radius of the sphere: this decrease being about 80 per cent. Beyond this, continued decrease is at a progressively slower rate. Comparing the curves of *di* and $I_x$ref we note that these effects operate in opposite directions, luminous intensity decreasing as reflection area increases. In effect, differences in luminous intensity are greatest for peripheral reflections where image dimensions are least, consequently there must be at some point a value of dX_b for which reflection and background luminous intensities are visually, though not actually, identical. In practical work this visual identity will take place somewhere inside the real periphery. This loss of dimension in the negative image will be equal to the displacement of the apparent periphery, and will depend on exposure, contrast and magnification factors, increase in any one or all of these leading to increase of displacement and therefore of distortion.

Reduction of Secondary Reflection Distortions

Since the secondary light-source has both area and luminous intensity and both of these acting together create distortion, each in a different way, distortion can be reduced by reducing either one or both of these factors. The area is reduced by masking the background or the cone of incident light. If a small area of white is left round the specimen image the remainder of the negative can be opaqued by hand without risk of interfering with the specimen outline. This safety margin of background image on the negative can conveniently be about 2mm, which, if R = 1cm and Z = 58.3cm, gives:

$$dX_b = dY + 2mm = 1.0176cm + 0.2cm = 1.2176cm.$$

This gives *di* = 0.034mm (approx.)

which, according to its density on the negative, may or may not register on the print. If it does not register 0.068mm must be added to the image diameter of a 1:1 print. This safety margin is to be considered as a constant dimension of the negative image and it has been given the arbitrary value of 2mm. In making 1:1 prints the safety margin will have the same size as in the negative, but in reduced prints it will have a smaller size proportionate to the reduction factor, since the proportion of 2mm to image size is less for a large than for a small image. Therefore, by doubling the negative image size and keeping all other optical factors (i.e. θ_z) constant, and making from it a half-size print so that the print image is the same size as the specimen, the negative safety margin will be virtually halved and its image dimension reduced by nearly four times to 0.008mm.

The luminous intensity of those reflection areas that cannot be eliminated by the above methods may be reduced by tone separation. We have seen that at a certain point on the background, close to the visual periphery, the luminous intensities of background and reflection are identical, so that there is no possibility of separating these by tonal separation methods. On the other hand, by working inwards from this point of identity we meet with relatively great differences in luminous intensity as between points which are closely associated. The curve in Figure 14 shows that the slope here is nearly parallel to the y axis and continues to be so for the whole of this background area. This means that very close to the point of identity there is another point for which the luminous intensity is greatly different. It is this extremely small linear distance representing a considerable light intensity difference that may be used for the separation of specimen image from background image. Thus separation takes place between *outer* reflection tones and *inner* reflection tones. As mentioned, there is theoretically a slight loss of dimension in the process, this being a function of exposure, contrast and magnification, but this distortion is insignificant except in the most exacting work with print images that are much larger than negative images.

Summary

Background brightness is considered as a factor producing distortion of the image. The whiteness of white backgrounds is so related to the whiteness of specimens that under specified optical conditions when a curved specimen and plane background have identical reflection factors separation between their respective image tones may be produced solely by the curvature of the specimen. A method is suggested of separating closely associated specimen/background brightnesses by controlled increase of gamma during processing, an application of which may also be employed to reduce the intensity effect of background reflections. Means are discussed for measuring the luminous intensity and area of reflections in curved specular surfaces and for measuring dimensional distortions with convexly curved specular reflectors.

Reference Note

* For more detailed expositions on tone reproduction the reader is referred to: Tupper, J.L., "Photographic Tone Reproduction," Chapter 18 in Neblette: *Photography, Its Materials & Processes*: and Jones, A.L., "The Theory of Tone Reproduction," Chapter 20 in Mees, C.E.K.: *The Theory of the Photographic Process*.

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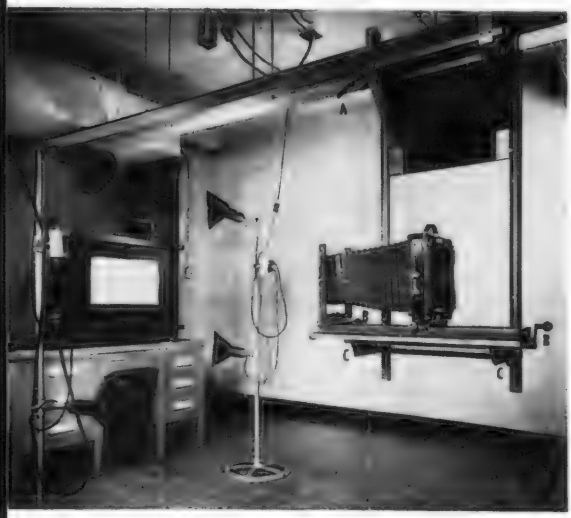


Overhead suspended copy camera as installed in the photographic department of The University of Chicago, University Clinics.

Overhead Copy Camera Carriage

J. W. CRUNELLE

Director, Photographic Dept., University Clinics
The University of Chicago, Chicago, Illinois

THE above illustrated overhead copy camera carriage is suspended from a 10 inch steel beam which extends 16 feet across the camera room. Four bearing wheels with 3/8 inch grooves travel on a 3/8 inch track on either upper edge of the beam. Levers A-A supply the breaking action for locking the carriage in place. B-B controls vertical movement of the camera bed. C-C controls tilting of the camera bed. The book and copy holder is hinged and moves backward for loading. In the vertical position it rests on rollers which permit the copy holder to move laterally and is controlled from the camera position (not shown in illustration).

An 8 inch x 10 inch camera is used with reducing backs down to 3¼ inch x 3¼ inch. The camera may be revolved to the opposite direction for the reproduction of radiographs, which accounts for the dual controls.

Advantages

The overhead copy camera carriage has several advantages over more customary copying equipment. The principal advantages are:

1.) Freedom from any obstruction for the operator

2.) Ease in operation, as the camera carriage moves smoothly with precision

3.) Constant alignment

4.) No floor obstructions

BOOK REVIEWS

KODAK PHOTOGRAPHIC MATERIALS AND LIGHT FILTERS FOR THE LABORATORY, *Eastman Kodak Company, Industrial Photographic Division, Rochester 4, N.Y., 19 pages (1954), 8½ in. x 11 in., free.*

This is a descriptive booklet on Kodak photographic materials and light filters for the laboratory. Object of the booklet is to save time and effort for scientific and industrial users by summarizing the facts about the various materials — both familiar and obscure — which Kodak offers for scientific photography. It is divided into the following categories: (1) Materials for general photography and photomicrography, (2) materials for the specialized recording of radiation, (3) materials for general spectrochemistry, (4) materials for the deep ultraviolet, (5) materials for the infrared, (6) materials for autoradiography and nuclear particle tracks, (7) materials for electron imagery, (8) material for the finest image detail, (9) materials for modifying spectral distribution, (10) materials for attenuating light, (11) and materials for other photographic techniques.

DU PONT DATA BOOKLET, *Du Pont Photo Products Department, Wilmington, 98, Delaware, 18 pages (1954), free.*

A helpful booklet for business-industry users of photographic papers for reproduction of documents, charts, graphs, etc. The booklet contains detailed descriptions of Du Pont reproduction papers and their applications. Surfaces, weights, and sizes are given for Du Pont "Photo-Writ", Copytone, Reflex Copy, and "Cap Solar" papers.

Of particular value is a section devoted to the cause and prevention of print defects, such as stains, blisters, and spots. Recommendations for proper safelights, exposure, and processing are given, along with a listing of processing formulas for Du Pont papers. For users who mix their own chemicals, eight conversion tables are conveniently included. Printed in two colors, the booklet is attractively illustrated with photographs and charts.

CHAMBER'S SHORTER SIX-FIGURE MATHEMATICAL TABLES, *L. J. Comrie, Chemical Publishing Company, Inc., 212 Fifth Ave., New York, N.Y., 387 pages, 7 in. x 10 in., (1954), cloth bound, $6.50.*

This is an extensive compilation of mathematical tables including trignometric functions, logarithms, logs of trignometric functions of angles, natural logs, powers, roots, reciprocals, factors and factorials, prime numbers, etc. The introductory part of the book gives a complete explanation of the use of each table. There are also conversion tables, numerous physical and mathematical constants and a table of proportional parts. The book is well printed and not set in such small type as to make it difficult to find particular values.

THE EFFECTIVE USE AND PROPER CARE OF THE MICROSCOPE, *Oscar W. Richards, American Optical, Instrument Division, Buffalo 15, New York, 63 pages (1954), 5¼ x 7⅝ in., illustrated, paper bound, 25c.*

Dr. Richards' small manual on the effective use and proper care of the microscope has become a classical reference for the beginner in microscopy since its first appearance in 1941. However, I dare say that if an examination were given to a group of so-called experienced microscopists on every point covered in his treatment there would be few 100% grades. The subject is covered in nine sections, preceded by a basic summary, and followed by the author's final words of advice and a selected bibliography, including a list of important journals that publish papers on microscopy and related subjects. It is an excellent bargain (only twenty-five cents) and should be a part of everyone's library who makes use of the microscope.

Dr. Richards states in his concluding remarks that the beginner in microscopy should not be discouraged if at first less is seen than anticipated. It was this reviewer's early experience that much more was always seen than anticipated, i.e., dirt and other artifacts, that were more difficult to cope with than some of the more technical aspects of microscopy.

New Products

NEW MICROPRINT READER

A new reader for "Microcards" and other forms and sizes of opaque microprint cards has been put into quantity production by the Eastman Kodak Company. Known as the Kodagraph Microprint Reader, Model A, it has been designed to make the use of microprint more comfortable and therefore more acceptable to researchers, librarians, educators, scientists, and others who have to cope with voluminous literature.

The reader features a typewriter-like roller which grips the card and enables the user to select by a quick, simple movement the portion of the card bearing the pages with the desired information. This roller accommodates all sizes of microprint cards up to 8 inches by 14 inches and thus involves no commitment to any one standard of microprint card size. The inertia of the roller is such as to provide good vertical and horizontal control despite the ease of movement.

Page images are seen on a green viewing screen made of a special material developed by Kodak to eliminate the glare spot usually found troublesome in viewing a brightly lit ground glass. The greater light diffusion provided by this material permits several persons to read from the screen at the same time. The inclination of the screen from the vertical has been made 11 degrees, as a result of a study by Kodak of the head positions assumed by persons using such devices. The reader contains an illuminating system powerful enough to permit comfortable reading in a normally lit room. Despite the large amount of light produced in the machine, the cooling system keeps all external surfaces comfortable to the touch and prevents damage to the cards. Kodak designed a special lens for the reader to work from the curved surface of the roller platen. This magnifies the microprint image 22 times onto the 8¾ inch by 10½ inch screen. The result is that in many cases the image has print larger than the original text. According to Kodak, this net magnification, combined with the extraordinary definition of the lens, makes the microprint image often "more" legible than the original.

The Kodagraph Microprint Reader measures 17½ inches high by 22 inches deep and 14 inches wide. It weighs about as much as an ordinary office typewriter and operates from a 110-115-v AC supply. Priced at $300, it is available through Kodak Microfilm dealers throughout the United States. The names of Kodak Microfilm dealers in your area can be obtained from the Sales Service Dept. of Eastman Kodak Co.

OMEGA 120 CAMERA

Simmons Bros., Inc., 30-28 Starr Ave., Long Island City 1, N.Y. have introduced their new Omega 120 camera which probably has more novel features than any single camera offered in many years. It has a 90mm coated Omicron, f/3.5 lens (Wollensak), a Rapax shutter with speeds from 1 second to 1/400 second, and XFM synchronization. The image size is 2¼ in. x 2¾ in., which is the 4 in. x 5 in. proportion, giving 9 exposures on No.

120 film. The camera has a die cast magnesium body, magnifying range finder, large focusing knob, auto-parallax correction, long stroke shutter release, side hand grip, automatically operated and retracted film pressure plate, double exposure prevention, special camera lock, rotary flash lamp attachment which holds six lamps, rapid sequence exposure mechanism, etc. Exclusive of accessories the price is $247.50. Data on available accessories can be obtained from the manufacturers.

POLAROID LAND CAMERA IN NEW SIZE

A smaller, lower-priced Polaroid picture-in-a-minute camera which is said to produce finished permanent prints at less cost than conventional pictures went on sale June 13 throughout the country. The camera uses a completely new film to produce prints in the popular wallet size (2¾" x 3½"). These pictures are produced in essentially the same fashion as with the original Polaroid Land Camera — the shutter is snapped, a tab is pulled, and 60 seconds later a dry picture is lifted out of the back of the camera. The new camera, named the "Highlander", and the special new film for it were both piloted under the direction of Dr. Edwin H. Land, President of Polaroid Corporation and inventor of the picture-in-a-minute process which bears his name. Finished in gray with chrome trim, the camera is only 7½ inches long, 4½ inches wide, and 2½ inches thick when folded — small enough to slip into a man's coat pocket or a woman's purse.

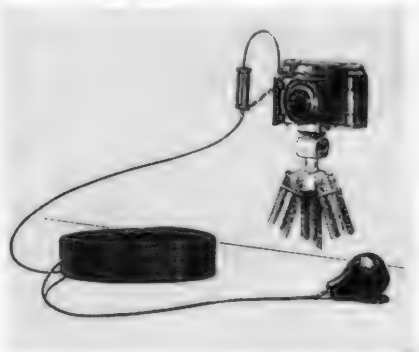
Some of the parts of the camera that control development of the picture must be accurate to within 15/100,000th of an inch — about 1/10th the thickness of a human hair. To turn out such parts in quantity meant new tool-making and manufacturing techniques never before used in the photographic industry.

A single numbered dial selects the right lens and shutter speed combination for any kind of light — whether it be a rainy day or an extra bright day on the beach. Outdoors, this number is determined either by a simple exposure guide or by a Polaroid exposure meter which clips right to the camera. The user points the meter, reads the number on the meter and sets this same number on the camera. For flash pictures, a glance at a card on the back of the flash gun tells the user which number to use. The price of the new camera is $69.95 and the film for it costs $1.19 for a roll that produces 8 finished pictures.

The film is a completely new product which incorporates all of the improvements developed in Polaroid's laboratories in recent years. It features a hard, glossy, plastic-surfaced paper which gives a sharper, crisper, permanent picture.

REMOTE CONTROL EXTENSION UNIT

The Kagra Remote Control Extension Unit, introduced recently by Willoughbys, 110 W. 32nd St., N.Y.C., permits photographers to take pictures of people, animals, wildlife, from a distance of up to 34 feet. The unit consists of two sections of specially made tubing, plus a rubber bulb. One section is 22 feet in length, and the other is 12 feet in length; with a metal connector. It is supplied with a Compur or Prontor release which is interchangeable with most standard releases, and can be used with practically every make and model of camera on the market. Covers all speeds, as well as Bulb and Time, with a flashgun or electronic flash unit. The bulb can be held in the hand, between the knees, or depressed by foot. The unit comes in a zipper-closed, simulated leather case. Price $10.95.



NEW BERTHIOT 3" f/3.5 TELEPHOTO FOR 16mm CAMERAS

Camera Specialtiy Company, Inc., 705 Bronx River Road, Bronxville 8, N.Y. announces they are exclusive representatives in the United States for the new Berthiot 3" f/3.5 Telephoto Lens for all 16mm cameras. This new 3" Tele-

photo Lens has a focusing mount, with focusing from 3½ feet to infinity. Diaphragm stops are from f/3.5 to f/22 with click-stops. It is factory coated, and is finished in chrome with a "C" mount. Price $43.50.

VITESSA 35mm SEQUENCE PICTURE CAMERA

Camera stores are now introducing the new model Voigtlander Vitessa 35mm Sequence

Picture camera which retails at $99.50, with Voigtlander's Color-Skopar f/3.5 color-corrected lens. This new model, which retains many features of the higher-priced Vitessa, is being marketed in the United States by Willoughby's, 110 W. 32nd St., New York.

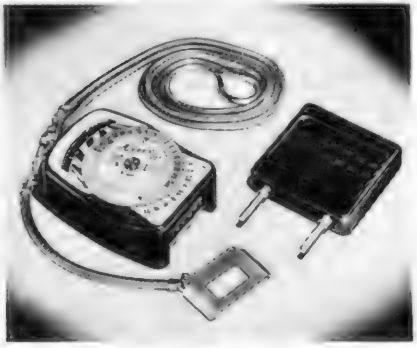
The Vitessa is said to be the only sequence picture camera of its kind. It will take up to 36 color or black-and-white pictures, one right after the other by merely pressing the right and left levers of the camera. When this is done the film is exposed, then is transported and the exposure counted and the shutter clocked, ready for the next shot.

The combined rangefinder and viewfinder is automatically compensated for parallax, and shows the correct field of view at all distances, even for close-ups from 3½ feet to 7 feet. The synchro-Compur M-X shutter is synchronized to accommodate all flash lamps and electronic flash units. Speeds range from 1 second to 1/500th second, time and bulb.

The Vitessa is flat, light in weight, and completely enclosed. The shockproof covers protect the lens. It can be used to take single snapshots as well as pictures in rapid sequence. For more information, see your camera store, or write Willoughbys, 110 W. 32nd Street, New York 1, N.Y.

NEW HORVEX EXPOSURE METER

The Prakticon Company, Inc., 705 Bronx River Rd., Bronxville 8, N.Y., have announced that they are the exclusive factory representatives in the United States for the new Horvex Exposure Meter. The meter permits one to take exposure readings both by reflected light or the incident-light method. The meter is converted from one method to the other by the removal or



insertion of an opal diffuser screen that slips in front of the photoelectric cell. It also has an "amplifier" unit that permits readings to be taken under extremely poor lighting conditions. Unit is plugged in on underside of meter. Price of meter $23.95; amplifier unit $7.50.

Your Association

A section of the Journal devoted to official announcements, chapter events, and other matters of historical significance to the Association.

EDITOR'S APOLOGIES

Your Editor regrets that space limitations in this number prevented the publication of Chapter News, and the list of Contributing Members which normally appears on the last page of the Journal. However, this does present an opportunity for extending the gratitude of the entire B.P.A. membership to our contributing members for having generously supported the activities of the Association during 1954.

MERWIN W. LA RUE HONORED

Twenty-six pioneers in the motion picture industry who have been active in the Society of Motion Picture and Television Engineers since 1924 or earlier were honored by this Society at a special "Pioneers' Dinner" held in Chevy Chase, Md. on the night of May 13, 1954. Among the twenty-six was our own jolly, capable Merwin W. La Rue. Merwin has been a member of the B.P.A. since 1941, and one of our most active. He is now a member of the Board of Directors. A recent picture of Mr. La Rue, which we publish with a great deal of pleasure, is reproduced below.

Merwin W. La Rue

CONCERNING ADVERTISING IN THE JOURNAL

Because of our exchange relationship with the British Medical Association whereby we publish the contents of their quarterly "Medical and Biological Illustration" and they publish the contents of J.B.P.A., inquiries have been received regarding the Journal policy on accepting advertising. Although we have seriously considered advertisements in the Journal, the policy at present remains the same as in the past several years. We shall not accept advertising until such time that a blanket decision is made, and this depends upon whether or not the balance between what the Journal can offer advertisers and what advertisers can be expected to pay for space turns in our direction to make advertising economically advisable.

PERSONALS

In view of the fact that the program for publishing the promised "News Bulletin of B.P.A." has been bogged down for the time being, the Editor has relented a bit in accepting a couple of personal items from members for this number of the Journal.

Mr. Gustav A. Haupt, Jr., 427 Maple Ave., Coatesville, Penna., is a collector of old microscopes and accessories. He is interested in purchasing such items, particularly a Powell and Lealand No. 1 Stand or a Watson Van Neurick Circuit Stage Stand. But he also has an interest in any old microscopes, objectives and accessories, regardless of condition. Write directly to Mr. Haupt and not to the Journal.

Mr. Clay Van Winkle, 600 West High St., Mt. Vernon, Ohio is another collector, but not of old microscopes. He is collecting 2 in. x 2 in. color slides of wild flowers and is interested in contacting members in his area who have a similar hobby.

Your Editor also has a "personal." He is trying to make a collection of good papers for the Journal, but his efforts so far have not been too successful. If it were not for the coopera-

tion of those authors whose papers have appeared in the Journal, there would be such a dearth of material that it would be impossible to continue publication. This is a sad commentary for such an active body of biological photographers as that which makes up the Association. Papers on original work, new equipment design, and practical methods or aids are eagerly sought.

DIRECTORY OF PROFESSIONAL MOTION PICTURE FILMS AND AUTHORS

This item does not directly concern the Association, but in the spirit of cooperation we are glad to announce in advance the publication of the "Directory of Professional Motion Picture Films and Authors" which is scheduled for release September 1, 1954. According to our colleague, Mr. C. D. Young, Director, Professional Publications, 2010 Kentucky Street, Lawrence, Kansas, a year of extensive effort has been spent in compiling the directory to make it a comprehensive, accurate, classified reference work on medical and dental motion picture films and authors. Biographical data on authors will be included and no doubt many B.P.A. members will be represented.

LEWIS W. KOSTER, NEW MEMBER JBPA EDITORIAL BOARD

Beginning with this number of the Journal, Mr. Lewis W. Koster becomes a member of the Editorial Board, replacing Mr. Harris B. Tuttle. The Editor wishes to thank Mr. Tuttle for his past cooperation, and to welcome Mr. Koster, who generously agreed to assist the Editor in New York. Mr. Koster is an active medical photographer in the Department of Surgery, Columbia University College of Physicians and Surgeons, New York, N.Y. Two papers of his have appeared in recent numbers of the Journal, and he has more in preparation.

NEW B.P.A. MEMBERS
(April through June, 1954)

Robert P. Barber, Decatur, Ill.
Dorothy Brower, Indianapolis, Ind.
Joseph Lawrence Clark, M.D., Ennis, Tex.
Douglas S. Cone, Jr., Atlanta, Ga.
Otis J. Cothron, Greenville, S.C.
Glen K. Davis, Houston, Tex.
Robert G. Davis, Detroit, Mich.
Charles J. Deutsch, Iowa City, Iowa.
Harold V. Green, Montreal, Canada
Walter Jacobson, Chicago, Ill.
David C. Johnston, M.D., Buffalo, N.Y.
Dr. Isaih Lew, New York, N.Y.
John L. Linder, Montreal, Canada
Robert A. MacMahon, MPT, Altoona, Pa.
L. A. Maxfield, Hartford, Conn.
Dr. Herbert A. Mercier, Meadville, Pa.
T. L. Nash, Lexington, Ky.
Evelyn M. Palmer, Harvey, Ill.
Ellis R. Rich, Loma Linda, Calif.
August P. Rossi, Taylor Center, Mich.
Dr. Robert Schrek, Hines, Ill.
Leonard Shaffer, Boston, Mass.
June Woodworth, Boston, Mass.

MEDICAL AND BIOLOGICAL ILLUSTRATION
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Gait, C. Engel and Peter Hansell
Henry Vandyke Carter, W. J. Bishop
Symposium of Graphic Methods
Explosion Hazard in Anaesthesia, A. W. Edridge
Infrared Kinematography, J. Rieck
X-ray Microscopy, V. E. Cosslett
Working Model of Automatic Drug Action, E. Grey Dimond, Kenneth Powell, and Ray Green
Equipment and Methods:
Concertina Booklets
Display Stands
Lyndale Print Portfolios
Ilford Junior Flash Gun
Fluorescent Photographic Papers
Premier Film Waxer
Annual Subscription (U.S.A.) $7.00
Published by the British Medical Association, Tavistock Square, London, England
Place orders with Grune & Stratton, Inc., 381 Fourth Avenue, New York 16, N.Y.

PROGRAM

BIOLOGICAL PHOTOGRAPHIC ASSOCIATION, INC.

24th ANNUAL MEETING

August 25, 26, 27

HADDON HOTEL, ATLANTIC CITY, NEW JERSEY

WEDNESDAY, AUGUST 25

8:00 Registration and Visit Technical Exhibits

10:00 Call to Order and President's Report

WARREN STURGIS, Sturgis-Grant Productions, Inc., New York, New York

Welcome

WILLIAM J. TAYLOR, Temple University Hospital, Philadelphia, Pennsylvania

10:30 Business Meeting

11:30 Visit Commercial Exhibits

12:30 Official Luncheon

1:30 Guest Speaker

STEPHEN P. DITTMANN, 1st Lt., MSC, Army Medical Service Graduate School, Washington, D. C.

Topic: Cinematography Under Difficulties, Illustrated with Medical Motion Pictures Made During the Korean War.

2:30 Closed-Circuit Color Television in Hospital Practice.

Panel Discussion by Members from Walter Reed Army Medical Center, General Electric Company and Wilmot Castle Company.

Station Television and Audio-Visual Kits for State-wide Medical Seminars.

DR. ROBERT WARNER, University of Utah, Salt Lake City, Utah.

Sound on Tape and Film.

FRANK ROGERS JR., Reeves Sound Craft Company, New York, New York.

Applications of Film Loops.

MARIA IKENBERG, University of Illinois, Chicago, Illinois and WARREN STURGIS, Sturgis-Grant Productions, Inc., New York, New York.

Triangle Stereophotography of the Ocular Fundus.

ERNEST ROSENTHAL, M.D., Yale University School of Medicine, New Haven, Connecticut.

5:00 Visit Technical Exhibit and BPA Exhibition.

THURSDAY, AUGUST 26

8:00 Visit Technical Exhibits and BPA Exhibition.

9:00 Optimum Lighting of Clinical Subjects.

FERDINAND HARDING, The Children's Medical Center, Boston 15, Massachusetts.

Standardized Photography of Orthopedic Cases.

JOHN A. GAUGHN, University of Rochester, School of Medicine, Rochester, New York.

A Photo-stand for Extremities.

PIERRE J. LEDOUX, Veterans Administration Hospital, Wood, Wisconsin.

An Improvised Surgical Camera.

LESLIE E. HIER, The University of Chicago, Chicago, Illinois.

The Preparation of Two Dimensional Illustrative Material for Photography.

LEWIS W. KOSTER, Columbia University, New York, New York.

Technic of Using 35mm Cameras in Medical Applications.

JACK FASON, Veterans Administration Hospital, Denver, Colorado.

Photography of Surgical and Research Apparatus.

LARDNER A. COFFEY, Mayo Clinic, Rochester, Minnesota.

1:00 Visit Technical Exhibit and BPA Exhibition.

2:00 Flexichrome Prints in Medical Applications.

L. S. PEDIGO, Michael Reese Hospital, Chicago, Illinois.

Standardization in Photography of Gross Specimens.

JULIUS HALSMAN, Armed Forces Institute of Pathology, Washington, D. C.

Radiography and Specimen Montages.

MARTHA BRUNINGS and JOHN J. BEITER, Rochester General Hospital, Rochester, New York.

A Masking Frame for Copying and Combining Radiographs.

L. J. SUNNY, Hahnemann Medical College, Philadelphia, Pennsylvania.

A System for Copying Radiographs.

NORMAN GAINES, Norman Gaines Studio, New York, New York.

4:00 Visit Technical Exhibits and BPA Exhibition.

7:00 Projection of Slides and Motion Pictures Accepted for the 1954 BPA Exhibition.

FRIDAY, AUGUST 27

8:00 Visit Technical Exhibits and BPA Exhibition.

9:00 Color Innovations for Microscopic Biological Specimens, Illustrated With Motion Pictures.

ROMAN VISHNAIC, New York, New York.

Fundamental Microscope Adjustments and Optical Combinations and Their Purposes.

JOHN V. BUTTERFIELD, Bausch & Lomb Optical Company, Rochester, New York.

Panel on Photomicrography of Medical Specimens.

JOHN J. BEITER — JOHN V. BUTTERFIELD — OSCAR RICHARDS — JULIUS WEBER.

Stereophotomicrography with Cameras of Fixed Interocular Distance.

OSCAR W. RICHARDS, American Optical Company, Southbridge, Massachusetts and HENRY M. LESTER, New York, New York.

11:00 Business Session

1:00 Visit Technical Exhibit and BPA Exhibition

2:00 Time-lapse Photomicrography.

M. H. CONSTANT, Canadian National Film Board, Ottawa, Canada.

Low-Magnification Photography in Transmitted Light.

JULIUS WEBER, Riverdale, New York.

A Method of Preparing Quality Lantern Slides Quickly.

HOWARD TIBBE, University of Utah, Salt Lake City, Utah.

Utilizing Miniature Black-and-White and Color Photographic Records.

C. E. ENGEL, Guy's Hospital, London, England — read by C. G. BROWNELL, Medical Division, Eastman Kodak Company, Rochester, New York.

Making Lantern Slides with Fototype.

LESTER HEITLINGER, Veterans Administration Hospital, Tucson, Arizona.

Making Microfilm Negatives.

FRANK C. REED, New York State Department of Health, Albany, New York.

4:30 Finish Projection of BPA Motion Pictures.

EVENING

6:30 Cocktail Hour — Host, Eastman Kodak Company.

7:30 Awards Banquet.

SUSTAINING MEMBERS

AMERICAN SPEEDLIGHT CORPORATION
ANSCO
BURLEIGH BROOKS COMPANY
CORECO RESEARCH CORPORATION
ELGEET OPTICAL COMPANY
GAMMA INSTRUMENT COMPANY
W. J. GERMAN, INC.
GRAFLEX, INC.
HARRISON & HARRISON
MEDICAL PRESS, INC.
PAILLARD PRODUCTS, INC.
POLAROID CORPORATION
SILGE & KUHNE
W. M. WELCH MFG. CO.

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HARRIS B. TUTTLE
LLOYD E. VARDEN
VERLIN Y. YAMAMOTO
STELLA ZIMMER

FELLOWSHIP PROCEDURE

Members may propose for Fellowship in the BPA other members whom they consider worthy of recognition. To be eligible for Fellowship a candidate must have been a member of the Association for five consecutive years and must possess one or more of the following qualifications:

Superior craftsmanship in still or motion picture photography of biological subjects. Ability in photographic research in new methods or materials.

(These require submission of evidence.)

Meritorious contributions to biological photography overall through sustained organizational work.

Two sponsors are required. The sponsors should be well acquainted with the candidate's work and should be ready to furnish the Board with details of his experience and achievements. Those who wish to sponsor a member whom they believe to be eligible should request a Fellowship Application form from the Secretary of the Fellowship Committee: Miss Anne Shiras, Photographic Department, Magee Hospital, Pittsburgh 13, Pennsylvania.

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